# 1979 Bay Area Air Quality Plan

## SAN FRANCISCO BAY AREA ENVIRONMENTAL MANAGEMENT PLAN

January 1979



Prepared by

ABAG
ASSOCIATION OF BAY AREA GOVERNMENTS

BAY AREA
AIR QUALITY
MANAGEMENT DISTRICT

MTC
Metropolitan
Transportation
Commission

With assistance from

CALIFORNIA AIR RESOURCES BOARD
CALIFORNIA DEPARTMENT OF TRANSPORTATION

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ABAG

# Association of Bay Area Governments

Hotel Claremont • Berkeley, California 94705 • (415) 841-9730

January 13, 1979

Mr. Tom Quinn, Chairman
Air Resources Board
P. O. Box 2815
Sacramento, California 95812

Dear Tom:

Enclosed is the 1979 Bay Area Air Quality Plan, adopted today by the General Assembly of the Association. This plan updates the Air Quality Maintenance Plan for photochemical oxidant adopted by the Association in June 1978. It is submitted to meet the requirements of the Clean Air Act, as amended in 1977.

We pledge to work closely with you and the Air Resources Board in its public hearing process on this plan, so that it may be submitted to EPA with other non-attainment area plans in the revised State Implementation Plan. As I indicated in my letter to you of November 20, 1978, local governments of the Bay Area urge that the ARB hearing on this plan be conducted at a location and time convenient to Bay Area residents.

Based on the extensive cooperation between the ARB and the three agencies engaged in air quality planning, we believe any matters still in question can be resolved in the continuing air quality planning process. Our 1979 plan, while it recognizes the important progress achieved to date, provides for an ambitious air quality planning program to be carried out in the region over the next three years, with a major revision scheduled to meet the 1982 plan submission requirements of the Clean Air Act.

Sincerely,

Rod Diridon, President
Supervisor, Santa Clara County

cc: Mr. Tom Austin, Executive Officer, ARB
Mr. Paul DeFalco, Regional Administrator, EPA

ASSOCIATION OF BAY AREA GOVERNMENTS

GENERAL ASSEMBLY RESOLUTION NO. 1-79

ADOPTION OF THE 1979 BAY AREA AIR QUALITY PLAN
(REPLACING CHAPTER VI OF THE ENVIRONMENTAL MANAGEMENT PLAN)

WHEREAS, the Association of Bay Area Governments was designated in May 1975 by the State Water Resources Control Board and in June 1975 by the Environmental Protection Agency under Section 208 of the Federal Water Pollution Control Act to carry on areawide waste treatment planning; and

WHEREAS, a work program for preparation of an integrated Environmental Management Plan, covering water quality, air quality, solid waste and water supply was prepared and submitted to EPA and approved by EPA in June 1976; and

WHEREAS, the Association was designated by the Air Resources Board in February 1977 to prepare an Air Quality Maintenance Plan under the Clean Air Act of 1970; and

WHEREAS, the Association, with the assistance of the Bay Area Air Pollution Control District, the Metropolitan Transportation Commission, the California Department of Transportation, the Air Resources Board, prepared an AQMP addressing the region's photochemical oxidant problem as a part of the draft Environmental Management Plan; and

WHEREAS, the draft Environmental Management Plan was issued for public review and comment in December 1977; and

WHEREAS, public hearings and extensive intergovernmental consultations were held on the draft plan; and

WHEREAS, the General Assembly on June 10, 1978, by Resolution 1-78 certified an Environmental Impact Report on the proposed Environmental Management Plan and by Resolution 2-78 adopted the Environmental Management Plan for submission to the Governor of the State of California in accordance with its environmental management work program approved by EPA; and

WHEREAS, the Air Resources Board in December 1977 notified local agencies of the designation of the San Francisco Bay Area Air Basin as a non-attainment area under the Clean Air Act Amendments of 1977; and

WHEREAS, the Association was designated in April 1978 by the Air Resources Board as the air quality planning organization responsible, under Section 174 of the Clean Air Act, for the

preparation of the non-attainment plan required by Section 172 of the Clean Air Act (hereinafter referred to as the 1979 Bay Area Air Quality Plan); and

WHEREAS, a memorandum of understanding was executed by the Association, the Bay Area Air Pollution Control District and the Metropolitan Transportation Commission in June 1978 delineating the respective responsibilities for preparation of portions of the 1979 Bay Area Air Quality Plan (hereinafter referred to as the memorandum of understanding); and

WHEREAS, the Association's Regional Planning Committee has overseen the development of the 1979 Bay Area Air Quality Plan; and

WHEREAS, the Association in October 1978 published a draft for public review of carbon monoxide and total suspended particulate control programs; and

WHEREAS, the Regional Planning Committee and Executive Board have held public discussions on several occasions about the carbon monoxide and particulate control programs; and

WHEREAS, the Association's Executive Board, acting for the General Assembly, conducted a public hearing on the carbon monoxide and total suspended particulate control programs document on December 21, 1978; and

WHEREAS, the Executive Board, upon conclusion of the public hearing and advice of the Regional Planning Committee, directed that necessary explanatory text addressing Air Resources Board staff comments on Chapter VI of the Environmental Management Plan be prepared; and

WHEREAS, the Executive Board directed also that Chapter VI of the Environmental Management Plan, the additional explanatory text, and the carbon monoxide and total suspended particulate control programs document be combined into the 1979 Bay Area Air Quality Plan to meet the requirements of the Clean Air Act, as amended in 1977; and

WHEREAS, the 1979 Bay Area Air Quality Plan has been prepared; and

WHEREAS, the General Assembly has considered the interim actions taken by the Bay Area air quality staffs, Regional Planning Committee, and Executive Board to meet the 1977 Clean Air Act requirements under severe time and financial constraints;

NOW THEREFORE BE IT RESOLVED that the General Assembly reaffirms the measures adopted in June 1978 to control hydrocarbon emissions to attain and maintain the oxidant standard, and by such affirmation incorporates Resolutions 1-78 and 2-78 herein by reference; and

BE IT FURTHER RESOLVED that, pursuant to Article 5.5 of the Government Code of the State of California, the General Assembly adopts the 1979 Bay Area Air Quality Plan, replacing Chapter VI of the Environmental Management Plan, and transmits the 1979 Bay Area Air Quality Plan to the Air Resources Board for inclusion in the State Implementation Plan; and

BE IT FURTHER RESOLVED that the Bay Area, acting in accordance with the requirements of the Clean Air Act, cannot demonstrate attainment of the one-hour 0.08 ppm Federal oxidant standard by 1982 despite implementation of all reasonably available controls; and

BE IT FURTHER RESOLVED that the Bay Area, acting in accordance with the requirements of the Clean Air Act, cannot demonstrate attainment of the eight-hour 9 ppm carbon monoxide standard by 1982 despite implementation of all reasonably available controls; and

BE IT FURTHER RESOLVED that the General Assembly requests the Administrator of the Environmental Protection Agency to grant an extension to December 31, 1987, in the deadline for meeting the Federal oxidant and carbon monoxide standards; and

BE IT FURTHER RESOLVED that the General Assembly requests the Administrator of EPA to redesignate Alameda County as an attainment area for the Federal primary total suspended particulate standard; and

BE IT FURTHER RESOLVED that, because the 1979 Bay Area Air Quality Plan indicates that estimation and control of fugitive dust will be a demanding and critical task and because existing reasonably available controls are insufficient to show attainment of the Federal secondary TSP standard by 1982, the General Assembly requests, pursuant to 40 CFR 51.31, the Administrator to grant an 18-month extension of the date for submittal of a plan to attain the Federal secondary total suspended particulate standard; and

BE IT FURTHER RESOLVED that the Association in accordance with the provisions of Chapter VIII of the Environmental Management Plan, the 1979 Bay Area Air Quality Plan, and the memorandum of understanding, is committed to the continuous air quality planning process envisioned by the Clean Air Act; and

BE IT FURTHER RESOLVED that Federal and State financial support and cooperation to obtain appropriate implementing legislation should be provided in a timely manner to avoid substantial delay in meeting the 1982 planning requirements; and

BE IT FURTHER RESOLVED that the Air Resources Board is requested to act on the 1979 Bay Area Air Quality Plan expeditiously and after a public hearing in the Bay Area; and

BE IT FURTHER RESOLVED that the Executive Board is directed, between this date and the General Assembly's meeting in June 1979, to fulfill any obligations assigned to the Association (including that of Article 5.5 of the Government Code of the State of California) with respect to State agency actions on the Environmental Management Plan, including the 1979 Bay Area Air Quality Plan; and

BE IT FURTHER RESOLVED that the Executive Board report to the General Assembly in June 1979 on any actions taken pursuant to Article 5.5 of the Government Code between adjournment of the General Assembly this day and the June 1979 General Assembly.

The foregoing resolution was approved by the General Assembly this 13th day of January, 1979.

Attest:

Revan A. F. Tranter
Revan A. F. Tranter
Secretary-Treasurer

Signed:

Rod Diridon
Rod Diridon
President

# 1979 Bay Area Air Quality Plan

## San Francisco Bay Area

Note: This plan replaces Chapter VI of the
Environmental Management Plan.

January 1979

Prepared by

ABAG
ASSOCIATION OF BAY AREA GOVERNMENTS

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

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# Section-A
# PURPOSE OF THIS CHAPTER

This chapter describes a plan for dealing with the Bay Area's air quality problems. The plan addresses air quality standards set by the Federal and State governments to protect public health. The plan proposes a range of controls to meet air quality standards. It sets forth an approximate time schedule for adopting and implementing the proposals if the deadlines of Federal law are to be met. These deadlines are described in the Clean Air Act Amendments of 1977. The law requires all areas of the country, including the Bay Area, to meet the primary ambient air quality standards by 1982. Under special conditions, described in this chapter, the deadline may be extended by the Environmental Protection Agency to 1987.

The San Francisco Bay Area is designated under the 1977 Clean Air Act as a region where three national ambient air quality standards are being exceeded. A map of the air basin is shown in Figure 1. Under the 1977 Clean Air Act, the Association of Bay Area Governments was designated by the California Air Resources Board to prepare, in cooperation with the Bay Area Air Quality Management District and the Metropolitan Transportation Commission, a non-attainment plan for meeting Federal standards for oxidant, carbon monoxide (CO) and total suspended particulates (TSP). This plan is required under Section 172 of the Federal Clean Air Act. It is to be included in a revised State Implementation Plan and submitted to the U.S. Environmental Protection Agency (EPA).

ABAG's General Assembly adopted an air quality maintenance plan in June 1978. That plan was designed to reduce hydrocarbon emissions, provide for attainment of the Federal oxidant standard by 1985-87 and maintain the standard thereafter. The AQMP formed the basis for the oxidant control strategies of this chapter, which is the Bay Area's non-attainment plan. This chapter, entitled the 1979 Bay Area Air Quality Plan, also addresses the carbon monoxide and total suspended particulate problems in the region.

The 1979 Bay Area Air Quality Plan is summarized in the next section. Section C provides background information about previous air quality planning in the region and status of existing air quality control programs. Section D defines air quality problems and their causes, and assesses future air quality conditions.

Sections E through M cover the oxidant problem in the Bay Area. Section E describes projected air quality in the Bay Area if no further controls are implemented, and Section F discusses alternative solutions to the projected oxidant problem. Section G contains extensive documentation of the transportation control strategies analyzed by the Metropolitan Transportation Commission in support of the air quality planning program.

Much of the technical analysis to support the oxidant control recommendations is described in Section H. Section I describes the plan recommendations for meeting the oxidant standard. Sections J and K summarize how the plan is to be implemented and enforced, and what costs and benefits are associated with the plan. Section L provides a bibliography of selected plan support documents. Sections M and N contain other support materials.

The carbon monoxide problem in the Bay Area, alternative solutions, plan recommendations, and supporting information are covered in Sections O through T. Total suspended particulates are covered in Sections S through W.

This plan represents a cooperative, multi-agency effort over the past three years--first to develop an AQMP for oxidant to meet the requirements of the 1970 Clean Air Act (adopted by ABAG's General Assembly in June 1978) and second to develop controls for carbon monoxide and total suspended particulates. The resulting effort is the 1979 plan required by Congress in the 1977 Amendments to the Clean Air Act. Section X describes how the 1979 plan will be updated in the future, as required by the Clean Air Act.

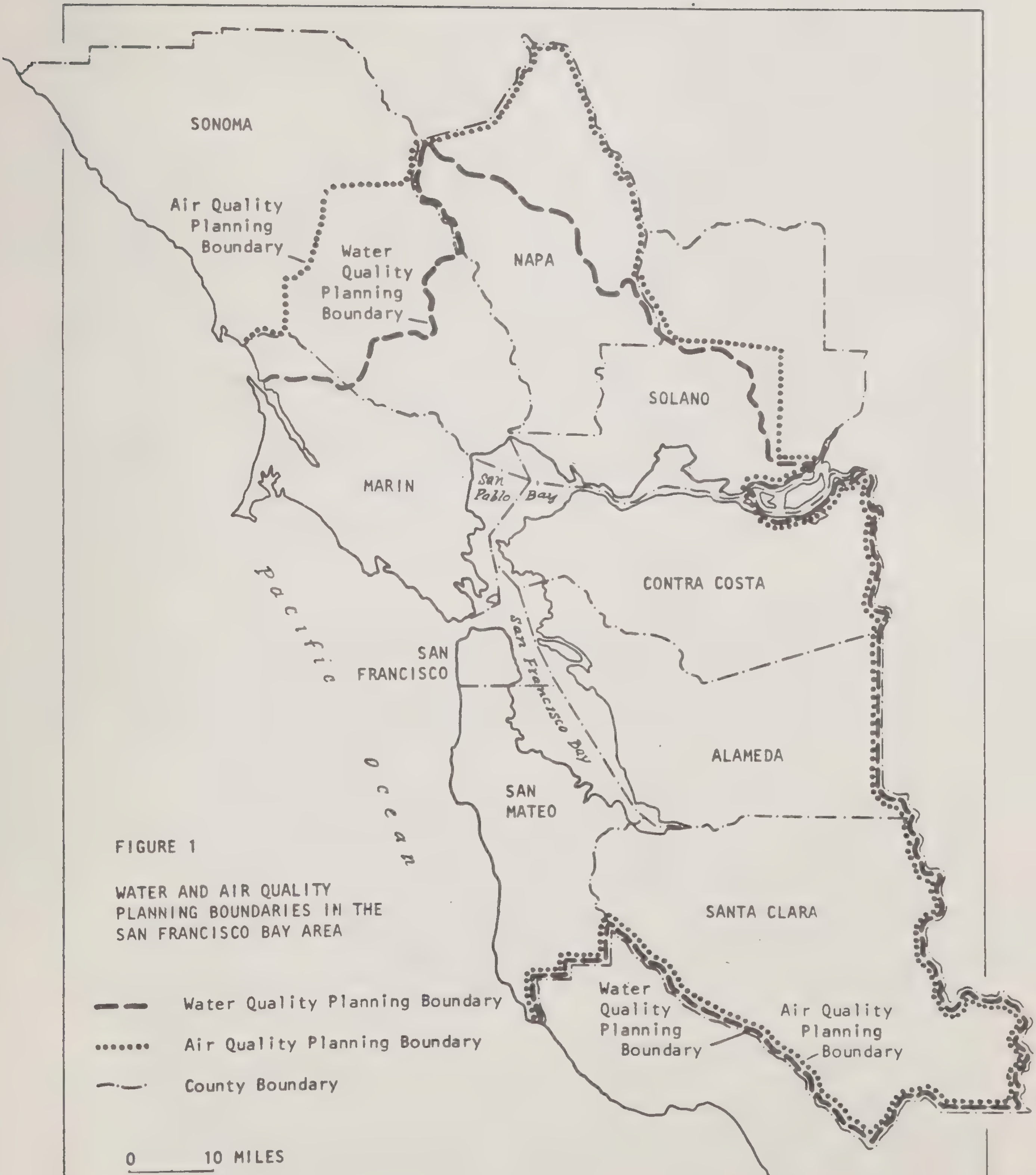



FIGURE 1

WATER AND AIR QUALITY PLANNING BOUNDARIES IN THE SAN FRANCISCO BAY AREA

# Section-B

# SUMMARY OF PLAN RECOMMENDATIONS

This plan addresses the problems of air quality. It is required by Federal law. This law--the Federal Clean Air Act Amendments of 1977--requires that all areas of the country, including the Bay Region, must meet established air quality standards by 1982. Under special circumstances for certain kinds of air pollution, the date for meeting the air quality standards can be extended to 1987. The measures needed to meet the standards and the schedule for implementation will undoubtedly cause wide discussion and controversy.

Many consider the Federal Act to be a good one--one that will lead to clean, healthy air in the Bay Area. Others consider the Act to be unrealistic and its requirements impossible to meet. This plan describes what actions would be needed to meet those requirements. The actions are set forth as proposals for satisfying the requirements of the Act. To complete the analysis, the benefits and costs associated with the proposed plan are identified.

## INTRODUCTION

Prior to the 1977 national legislation, the major national impetus for formal air quality planning was the Clean Air Act of 1970. This act required each state to prepare state implementation plans for how ambient air quality standards were to be met by 1975, or 1977 at the latest. These Federal air quality standards were established by the U.S. Environmental Protection Agency (EPA) to protect public health.

For a variety of reasons--technical, political, institutional, and legal--California has never had a completely acceptable (or "approvable") state implementation plan for the Bay Area. One pollutant in particular, photochemical oxidants (sometimes referred to as smog), has posed the most difficult problem for preparing an acceptable plan. Photochemical oxidants consist mostly of ozone ($O_3$). Oxidant is formed from the reaction of hydrocarbons and oxides of nitrogen in the presence of sunlight. In the Bay Area it is experienced regionwide with the most adverse levels occuring in the summer and fall months. Other air pollution problems also exist, however, and these will be described more fully in the following sections.

The air quality controls proposed for the 1979 Bay Area Air Quality Plan are designed to meet the requirements of the 1977 Amendments to the Federal Clean Air Act. In the case of TSP, the Clean Air Act requires attainment of the primary standard by 1982. In the cases of the oxidant and CO standards, attainment is also required by 1982, but an extension may be granted by EPA to 1987. An extension is possible if the standards cannot be met by 1982 despite implementation of all reasonably available controls.

AIR QUALITY STANDARDS

Both the EPA and California Air Resources Board (CARB) have established ambient air quality standards to protect public health. Meeting these standards and ensuring their continued maintenance is the basic goal of this plan. Because the Federal and State standards are different, the strategies required to meet the two sets of standards are also different. Table 1 presents the Federal and California air quality standards.

A brief summary of how each of the Federal and State standards was approached is presented below. It is important to note the distinction between Federal and State standards. Achieving and maintaining Federal air quality standards is required by Federal law; achieving and maintaining California air quality standards is required under State law. Fixed time schedules and interim requirements have been set for meeting the Federal standards. No such schedules or interim milestones exist for the California standards.

Photochemical Oxidants ($O_x$)

The Federal standard is more stringent and has been used as the basis for developing control strategies. To meet the Federal standard a comprehensive strategy is recommended, consisting of further technological controls for stationary and mobile sources along with transportation controls and improved land use management.

Carbon Monoxide (CO)

The Federal standards are more stringent than California standards. The one-hour 35 parts per million (ppm) standard is not currently violated and is not expected to pose future problems. The eight-hour 9 ppm standard is violated in a number of localized areas throughout the Bay Region. Strategies to deal with these problems are best developed on a case-by-case basis.

Nitrogen Dioxide ($NO_2$)

The Federal standard is an annual average and has never been violated in the Bay Area. The California one-hour standard is occasionally violated, mostly in the Santa Clara Valley. Because oxides of nitrogen can suppress oxidant formation (see Section F for detailed discussion), the control stragegy recommended is a cautious one. Further controls of nitrogen oxides are recommended only after a more detailed examination of the problem reveals what the likely sources of the problem are and that the proposed solutions will indeed be effective to deal with the problem.

Total Suspended Particulate (TSP)

Both the 24-hour and annual mean California standards are more stringent than the corresponding Federal standards. In 1975, both Federal and California annual averages were exceeded at a few inland valley areas within the region. Wind blown dirt and dust contribute significantly to total suspended particulate values, raising the important issue of natural versus man-made contributions to the particulate problems. Because the particulate problem occurs in relatively few areas (e.g., Livermore) and

Table 1. Federal and California Ambient Air Quality Standards

| POLLUTANTS | AVERAGING TIME | CALIFORNIA STANDARDS | NATIONAL STANDARDS [1] |
|---|---|---|---|
| Photochemical Oxidants | 1 Hr. | 0.10 ppm | 0.08 ppm |
| Carbon Monoxide | 12 Hr. | 10 ppm | |
| | 8 Hr. | | 9 ppm |
| | 1 Hr. | 40 ppm | 35 ppm |
| Nitrogen Dioxide | Annual Average | | 0.05 ppm |
| | 1 Hr. | 0.25 ppm | |
| Sulfur Dioxide | Annual Average | | 0.03 ppm |
| | 24 Hr. | 0.05 ppm [2] | 0.14 ppm |
| | 1 Hr. | 0.5 ppm | |
| Suspended Particulate Matter | Annual Geometric Mean | 60 $\mu g/m^3$ | 75 $\mu g/m^3$ |
| | 24 Hr. | 100 $\mu g/m^3$ | 260 $\mu g/m^3$ |
| Lead | 30 Day Average | 1.5 $\mu g/m^3$ | |
| Hydrogen Sulfide | 1 Hr. | 0.03 ppm | |
| Hydrocarbons (Corrected for Methane) | 3 Hr. (6-9 a.m.) | | 160 $\mu g/m^3$ |
| Ethylene | 8 Hr. | 0.1 ppm | |
| | 1 Hr. | 0.5 ppm | |
| Visibility Reducing Particles | 1 Observation | In sufficient amount to reduce the prevailing visibility to less than 10 miles when the relative humidity is less than 70%. | |

[1] National standards, other than those based on annual averages or annual geometric means, are not to be exceeded more than once per year.

National primary standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health. Each State must attain the primary standards no later than 1982. In the case of photochemical oxidants and carbon monoxide, extensions to 1987 at the latest may be granted if certain conditions set forth by the Clean Air Act of 1977 are met.

[2] With simultaneous violation of State 1-hour oxidant standard <u>or</u> State 24-hour suspended particulate matter standard.

natural contributions to monitored values are estimated to be quite significant, no specific recommendations are presented in this document. Until better data are available on the extent and causes of the problem, specific control recommendations should be deferred. The localized particulate problems should be treated on a case-by-case basis with appropriate controls being developed for each of the localized violations.

Sulfur Dioxide ($SO_2$)

The Federal annual average and 24-hour standards are met by a considerable margin in the Bay Region. Recently, however, California adopted a new 24-hour standard which states violations require a simultaneous occurrence with either oxidant or total suspended particulate at violation levels as well. Using this new California standard, the Bay Area does not appear to have a serious sulfur dioxide problem. Because of the unique manner in which California is now defining the sulfur dioxide standard, projecting future problems (and thus possible solutions to the problems) poses special difficulties. These are presented in Section X as areas for future research work.

Other California Standards

Unlike EPA, California also has ambient air quality standards for lead, hydrogen sulfide, ethylene, sulfates, and visibility reducing particulates. Each of these pollutants poses problems for control strategy development. A considerable amount of work is needed to define the extent of the problems, inventory sources of the problems, project what future problems will be, and to develop control strategies for dealing with the problems. These tasks are recommended for the continuing planning process and are described in Section X. It should be noted that the Bay Area Air Pollution Control District has regulations for industrial emissions of lead and hydrogen sulfide.

Summary of Air Quality Standards

Setting air quality standards is a difficult task. It is a dynamic process with standards constantly undergoing review as new medical research becomes available. Some standards change and others are established. For example, during the course of this study, the California Air Resources Board adopted a new 24-hour sulfur dioxide air quality standard. Sometime in 1978, EPA is required to set a new short-term nitrogen dioxide air quality standard (assuming the medical evidence supports the need for such a standard to protect public health). The photochemical oxidant standard is currently undergoing an extensive review by EPA.

Under the Clean Air Act of 1977, regular reviews of all air quality standards are required. The Federal standards set under the Clean Air Act of 1970 have remained unchanged despite several independent scientific reviews of these standards in the early 1970s. Regardless of whatever controversy exist with the standards and the levels at which they are established, the standards are set according to Federal and State laws. The plan by addressing the standards is addressing Federal and State laws and policies.

BAY AREA AIR QUALITY PROBLEMS

In its simplest form, air quality problems are easily defined. The Bay Area is not meeting air quality standards. Both existing and projected problems

are of concern. The previous discussion of the current standards touched upon the existing problems. Projected future problems are summarized below.

## Photochemical Oxidants ($O_x$)

It is generally agreed that the most difficult air quality standard to meet in the Bay Region is the Federal one-hour 0.08 ppm photochemical oxidant standard. Hydrocarbon emissions that lead directly to oxidant formation were estimated to be approximately 1000 tons/day in 1975. Under existing control programs, hydrocarbon emissions are projected to decrease by about 20% in 1985 to approximately 800 tons/day. By 2000, the hydrocarbon emissions are again projected to be approximately 1000 tons/day, or roughly the same emission levels as 1975. Thus, since oxidant levels experienced in the Bay Area in recent years reach 2-3 times the standard, one would expect a modest improvement by 1985, followed by a slow deterioration to current oxidant levels again by the year 2000. Oxidants are clearly an existing and projected air quality problem.

## Carbon Monoxide (CO)

A number of urbanized areas exceeded the Federal eight-hour 9 ppm carbon monoxide standard in 1975, e.g., San Jose, San Francisco, Oakland, and Vallejo. Regionwide emissions were estimated to be about 4,300 tons/day in 1975. Future emissions for 1985 and 2000 with existing programs are projected to be about 3,350 tons/day and 3,200 tons/day respectively. Since emissions are projected to decrease slightly from 1975-2000, it would appear there will continue to be localized problems unless additional controls are adopted.

Carbon monoxide is a very localized air quality problem caused almost exclusively by motor vehicle exhausts. Control strategies for existing and projected carbon monoxide problems need to be developed for the specific areas violating the standard.

## Nitrogen Dioxide ($NO_2$)

Nitrogen dioxide is not currently a major problem in the Bay Area. The Federal annual average of 0.05 ppm has never been exceeded. Oxides of nitrogen emissions projected for the region remain relatively constant over the 25 year planning time frame: 731 tons/day in 1975; 692 tons/day in 1985; and 721 tons/day in 2000. Thus, it is projected that the Federal nitrogen dioxide standard will not be violated in the future.

The California one-hour 0.25 ppm nitrogen dioxide standard is violated several times a year, particularly in the south Bay Area. Technically, the most controversial issue facing the Bay Area is whether or not additional controls of nitrogen oxides should be implemented and, if so, what controls are appropriate. This issue is extremely complex. Its resolution has implications for oxidant control strategies throughout California as well as many other areas of the country. What is recommended in the plan is that further nitrogen oxides controls be approached in the Bay Region with considerable caution.

Total Suspended Particulates (TSP)

Both Federal and State 24-hour and annual geometric mean standards for total suspended particulate are violated in different parts of the region with varying frequency. Since the State standards are more stringent, they are violated more frequently. Particulate problems tend to be localized. Thus, a knowledge of the sources contributing to the problem is desirable so that a discriminating and effective control program can be developed.

Devising such control programs is quite complex. There are many sources of particulate matter. From natural sources, particulate matter can come from ocean salt, soil particles, pollen, plant and insect parts. More comes from man's activities, however, from:

- combustion products in domestic, commercial, manufacturing, transportation, and agricultural activities
- rubber tires, brake linings and roadway dust from vehicle movements
- natural dusts raised by mining, quarries, agriculture and construction
- man-made particulate such as sawdust, paint spray and manufactures

All of the particulate sources cited above are primary sources, or particulate matter released directly into the atmosphere. Secondary sources of particulate matter (sometimes referred to as secondary aerosols) can also come from the formation of liquid or solid particulates by reactions of gases in the atmosphere.

Overall, the information currently available to develop an effective and discriminating control strategy for the particulate problem is not available.

Sulfur Dioxide ($SO_2$)

Sulfur dioxide emissions come mostly from the industrialized areas of Contra Costa County. Even here, however, both Federal 24-hour and annual average sulfur dioxide standards are not violated. In fact, the 1975 annual average high for the region was less than 40% of the Federal standard.

Because less natural gas is anticipated, sulfur dioxide emissions are projected to increase substantially in 1985 and 2000. The 219 tons/day estimated for 1975 are projected to increase to 435 tons/day in 1985 and 414 tons/day in 2000. The major factors influencing the projected sulfur dioxide emissions are State and Federal energy policies. For example, if the CARB petition to the California Public Utilities Commission were granted to allow natural gas from the Bay Area to be diverted to Southern California, sulfur dioxide air quality in the Bay Area would be degraded. Federal energy policies, some of which are currently being debated in Congress, may have other effects.

The current State 24-hour sulfur dioxide standard was violated once in 1975. By simply examining the sulfur dioxide emission trends, one would expect it will also be violated in the future. However, no model (simple or complex) currently exists to support such a statement. Thus, all that can be said regarding future violations of the State standard is they are likely to occur.

The newly defined sulfur dioxide standard poses special problems for air quality planning and control strategy development, namely:

- Projecting future air quality
- Estimating the effectiveness of control measures

These issues are proposed for detailed examination and resolution in the continuing planning process.

## OVERVIEW OF THE 1979 AIR QUALITY PLAN

It is generally agreed that the most difficult air quality standard to meet in the Bay Region is the Federal one-hour 0.08 ppm photochemical oxidant standard. Most of the discussion in the 1979 Bay Area Air Quality Plan is focused on the oxidant problem in the region. It includes an exhaustive examination of the nature of the problem, alternative control strategies, a comprehensive set of specific recommendations that, if implemented on the schedule adopted by the General Assembly, are estimated to reduce hydrocarbon emissions sufficiently to meet the oxidant standard by 1985-87. Attainment by 1982 of the 0.08 ppm standard is not possible in the Bay Area, and the five-year extension is being requested.

In the case of carbon monoxide, the plan describes the nature of CO problems in the Bay Area and outlines the technical difficulties in preparing a regional plan for a pollutant where levels vary widely throughout the region. The 1979 plan shows how several actions to control hydrocarbon emissions adopted by the ABAG General Assembly in June 1978 will also provide reasonable further progress in meeting the CO standard. However, a more extensive technical analysis of CO problems is necessary to demonstrate that attainment of the CO standard will be achieved at all locations. The plan outlines a program for development of a more technically defensible and publicly acceptable plan over the next two years to meet CO standards in the locations where the localized violations occur. Extensive involvement of local agencies is expected to produce more substantial progress at attaining the CO standard throughout the region.

In the case of total suspended particulates, the plan describes the recent history of violations of various Federal and State particulate standards, documents key factors behind the excessive particulate levels experienced in recent years, and describes how those factors have changed. Most recent monitoring data of the Bay Area Air Quality Management District shows the Federal primary standard is now being attained and the plan calls for redesignation of the Bay Area (specifically Alameda County) as an attainment area for the Federal primary TSP standard. The plan outlines a program for attaining other Federal and State particulate standards as part of the air quality continuing planning process.

## THE NATURE OF THE REGION'S OXIDANT PROBLEMS

Oxidants (primarily ozone) are formed in the atmosphere from emissions of hydrocarbons and oxides of nitrogen. Hydrocarbon emissions occur from a wide variety of sources--petroleum refineries, motor vehicles, dry cleaners, service stations, aircraft. The most significant source categories are organic compounds evaporation (otherwide known as organic solvents or volatile organic compounds) and both light and heavy duty vehicles. Each of these source categories has previously been the target of control efforts. Further

controls will be necessary if significant air quality improvement is to be made. Total hydrocarbon emissions were projected to decline somewhat by 1985 due to controls on the books (prior to adoption in June of the AQMP), but to rise again by the year 2000 to the 1975 levels, making it apparent that more controls are necessary. Such controls were identified in the process of developing the AQMP, and adopted by the General Assembly.

For oxides of nitrogen, the principal source categories are stationary source fuel combustion and motor vehicles. Efforts to control motor vehicle $NO_x$ emissions have been controversial in recent years, while stationary source $NO_x$ control has been limited to only the largest sources. The dilemma of pursuing $NO_x$ control is that $NO_x$ alone is not a problem in the Bay Area. It is a contributor to the photochemical oxidant problem, but its precise role has not been well defined to date. $NO_x$ emissions are projected to remain at a relatively constant level over the next 20-25 years.

By 1985, the expected increase in stationary source $NO_x$ emissions due to increased use of fuel oil will be offset by additional motor vehicle $NO_x$ control. By the year 2000, increased use of nuclear fuels for electric power and increased siting of electric power generating facilities outside of the Bay Area have been assumed to offset increased $NO_x$ emissions in other source categories.

The plan's analysis of oxidant control shows additional controls of $NO_x$ emissions beyond those currently planned for will worsen the oxidant air quality in the Bay Area. Because of the potentially counter-productive aspects of such controls, no additional $NO_x$ controls are proposed, while hydrocarbon emissions are to be reduced by 43% to meet the oxidant standard by 1985-87. Whether or not additional $NO_x$ controls are needed is discussed in the plan. The implications to be drawn are that hydrocarbons should be stringently controlled and that care should be exercised in deciding how much control of oxides of nitrogen emissions is appropriate. Technically, this is the most controverisal issue facing the Bay Region in dealing with the requirements of the Clean Air Act for attainment and maintenance of the oxidant standard.

## HYDROCARBON CONTROL STRATEGIES

The plan includes a broad-based strategy of additional technological controls for stationary and mobile sources, and transportation system improvements. The actions adopted by the General Assembly in June 1978 to reduce hydrocarbon emissions are summarized below.

*Stationary Source Controls*. Two basic programs would be carried out by the Bay Area Air Quality Management District. Both programs are controversial and will require considerable expenditures, primarily from private industry. These programs are:

- Use of available control technology (ACT) for new and existing industries.

- A review (and permit program) of new and modified air pollution sources to ensure use of ACT and a determination of the source's contribution to further violations of air quality standards. Permits are issued or denied on the basis of meeting the criteria specified in the Bay

Area Air Quality Management District's regulation, which has been in effect in various forms since 1972. It is currently reviewing the rule to consider options that conform to requirements of the Clean Air Act as amended in 1977.

*Mobile Source Controls.* These programs are basically hardware oriented or technological approaches to reducing vehicle emissions. Three programs are recommended for consideration by the California Air Resources Board. If carried out, these programs would result in lowered emissions from new passenger cars and trucks, periodic inspections of cars and trucks to keep them running as clean as possible, and lowered emissions from trucks currently in use.

For long term maintenance of the photochemical oxidant standard, after 1985-87, consideration would be given to reducing hydrocarbon emissions from small gasoline engines and/or from off-highway mobile sources.

*Transportation Improvements.* A variety of transportation system improvement measures would reduce the amount of vehicle travel within the region. These would be carried out by many agencies. The programs provide incentives to use transit and carpools. The measures include: additional transit service, increased bus and carpool lanes with ramp metering, more ride sharing services (e.g., jitneys and vanpools), and more extensive bicycle systems.

Most of the actions can be adopted by appropriate agencies within two years of plan approval. However, full implementation will realistically require several years beyond the adoption phase, particularly for the most significant programs such as the use of available control technology (ACT). It is therefore unlikely that the oxidant standard can be met in the Bay Area by 1982. The ultimate 1987 target year for attainment of the oxidant standard set by the 1977 Clean Air Act Amendments can be met through implementation of the actions adopted in June 1978.

In developing the plan to meet the oxidant standard, a number of alternative strategies have been analyzed. A broad based strategy, involving controls for stationary and mobile sources as well as transportation system improvements, has been developed. This strategy includes requiring permits for new and modified sources of air pollutant emissions (commonly referred to as the New Source Review rule).

The NSR requirements for permits should result in lower emissions than would be the case without new source review. The permits would be issued on a project-by-project basis. Therefore, the actual reductions in emissions cannot now be estimated, although a target can be established. The reductions will depend on the specifics of the permit regulations. As shown in Table 2, without considering these reductions, the controls in the broad-based strategy will almost reduce emissions enough to meet the 0.08 ppm oxidant standard in 1985. The additional reduction in emissions required to meet the standard can be achieved through the application of the New Source Review regulation. This regulation provides flexibility to the plan. An initial strict regulation can be changed and relaxed to some degree after it has been demonstrated that steady and further progress is being made toward meeting the air quality standard. As the attainment deadline dates approach and more data are available on air

Table 2. Hydrocarbon Emission Reductions Required to Achieve the 0.08 ppm Photochemical Oxidant Standard

| | 1985 (Tons/Day) | 2000 (Tons/Day) | |
|---|---|---|---|
| Base Line Emissions | 797 | 1058 | |
| Allowable Hydrocarbon Emissions[a] | <450 | <450 | |
| Hydrocarbons Remaining After Implementing Comprehensive Strategy | 511 | 604[b] | 545[c] |
| Additional Hydrocarbon Reductions Needed to Meet Standard | >61 | >154[b] | >95[c] |

[a] Varies as a function of oxides of nitrogen emissions and the spatial and temporal distribution of all precursor emissions.

[b] Assumes upper range of population forecast in Series 3 projections--6.1 million people in 2000.

[c] Assumes lower range of population forecast in Series 3 projections--5.4 million people in 2000.

quality trends, the New Source Review program can be reviewed to examine its overall effectiveness and whether the program should be relaxed or made more stringent.

The plan projections in 2000 (without New Source Review), assuming implementation of a broad based strategy, show violation of the oxidant standard. Again, continued application of this program could result in sufficient emission reductions to ensure long term maintenance. Year 2000 projections are inherently subject to greater uncertainty than 1985. Thus, the need for more (or possibly less) controls of hydrocarbons in 2000 will be examined again in subsequent plan updates.

A comprehensive strategy provides the bulk of the air quality improvement between now and the year 2000, while the role of the NSR program could be to provide the incremental emission reduction (or prevention) necessary to attain and maintain the Federal oxidant standard. As a comprehensive strategy is made more or less stringent, or if the oxidant standard is revised, restriction on new source development can accordingly be made more or less stringent.

It is intended that the air quality plan adopted for the Bay Area facilitate a reasonable level of industrial and commercial growth while achieving reasonable further progress toward attainment of ambient air quality standards. The air quality plan provides that this be accomplished through continued review of new and modified industrial and commercial facilities (new source review) using offset and/or other provisions of the Clean Air Act Amendments of 1977 to allow for a reasonable level of growth. Currently the only means of allowing major industrial growth is the case-by-case offset provision of New Source Review regulations. However, it is to soon to determine whether this provision will in fact allow a reasonable level of industrial growth. Therefore, in the continuing planning process as emission reductions and economic impacts are monitored, alternative procedures for permitting industrial growth will be evaluated and considered for inclusion in updated versions of the air quality plan.

Another key feature of the continuing air quality planning process is the adoption of specific actions to show maintenance of the oxidant standard after it is attained. The plan provides that the region:

> Adopt between 1985 and 1987, and implement in 1990 or thereafter, one or more of the following measures to ensure maintenance of the oxidant standard through the year 2000, subject to further evaluation of the measures during the continuing planning process:
>
> 1. Reduce hydrocarbon emissions from small gasoline engines.
> 2. Reduce hydrocarbon emissions from off-highway mobile sources.
> 3. Implement more stringent vehicle exhaust emission controls--approximately 60-80% reduction below 1977 prescribed levels.
> 4. Provide additional transit.

Based on extensive analysis, the General Assembly in June 1978 determined that this action was appropriate at this time to maintain the oxidant standard beyond 1985-87. The Clean Air Act requires the plan to demonstrate the ability to meet established Federal air quality standards (in this case the Federal photochemical oxidant standard) and to maintain the standard following attainment. Because they are needed for long-term maintenance, responsible agency(s) action to adopt and implement these additional measures will not be necessary prior to 1985. The maintenance measures are identified for further analysis during the continuing planning process, with one or more of the measures to be adopted as necessary to ensure maintenance of the current Federal oxidant standard after 1985-87. Part of the analysis will include detailed assessment of the impacts of the maintenance measures.

As pointed out in the plan, there are uncertainties about the effectiveness of the controls adopted by the General Assembly in June 1978 for controlling hydrocarbons. Because of the uncertainties in the forecasts, during the continuing planning process emission reduction estimates will be closely monitored. The effectiveness of the programs adopted will also be closely monitored. Appropriate adjustments will be made as additional information is gathered and the uncertainties are reduced. The forecasts on which this plan is based are as objective, rigorous and accurate as possible at this time.

The Clean Air Act Amendments of 1977, in addition to several other requirements, calls for the 1979 plan submittal required under Section 172 to demonstrate "reasonable further progress" toward attainment of the oxidant standard. Figure 2 shows the minimum reasonable further progress toward attainment of the oxidant standard by 1987, and estimates the effect of the hydrocarbon emission reduction controls included in the plan submitted by the Bay Area.

## THE NATURE OF CARBON MONOXIDE PROBLEMS

Carbon monoxide levels in urban communities vary widely with time and location. CO is emitted directly in the exhaust of motor vehicles, which is the principal source of CO emissions. Once in the atmosphere, meteorological factors such as winds and convective processes tend, under normal conditions, to rapidly disperse the pollutant. As a result, the typical distribution of ambient CO closely follows in time and location the distribution of motor vehicle traffic. High CO concentrations can therefore be expected in places where traffic is congested. In addition, traffic congestion involves vehicles which are operating at low speeds or idling, and which are accelerating and decelerating rather than moving smoothly. CO emission rates are substantially higher under such conditions, thus magnifying ambient CO concentrations. Research previously conducted has established that ambient CO levels are highest along busy city streets or highways, and drop rapidly with distance from the road. This "microscale" variation of ambient CO levels is in sharp contrast with photochemical oxidants, which tend to cover large regional areas.

The Federal ambient air quality standards for CO have been set at 35 parts per million (ppm) for one hour, and 9 ppm for eight hours. A CO problem

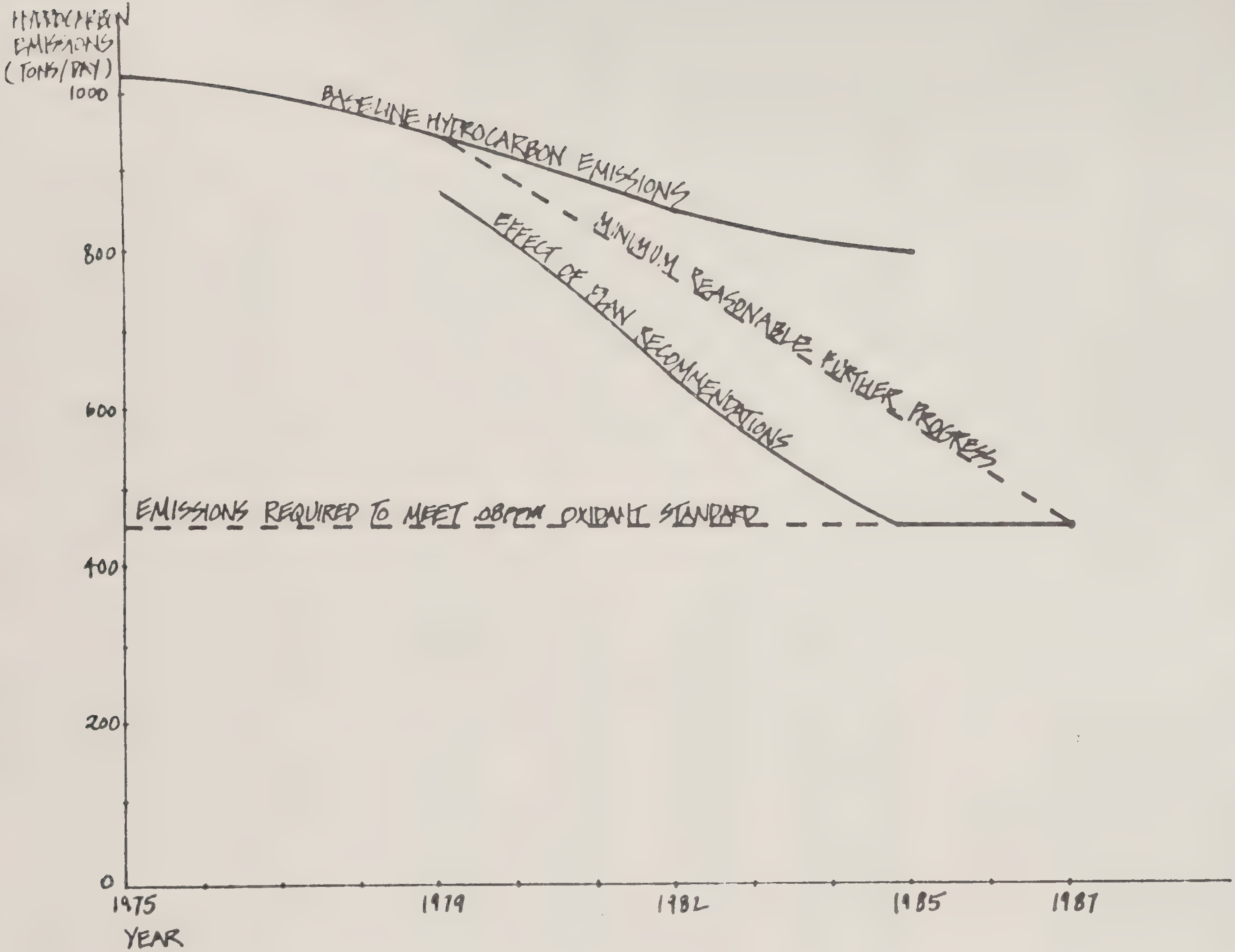



FIGURE 2

ESTIMATED REASONABLE FURTHER PROGRESS TOWARD ACHIEVING THE .08 ppm OXIDANT STANDARD IN THE SAN FRANCISCO BAY AREA.

may thus be defined as a violation of the one-hour or eight-hour Federal ambient CO standard. According to EPA guidelines, the National Ambient Air Quality Standards are applicable to that portion of the atmosphere, external to buildings, to which the general public has access. The key phrase is "to which the general public has access." Thus, regardless of the likelihood that any single individual would remain in a given location for one hour or eight hours to receive a CO exposure greater than that allowed by the standards, the standards must be met in such a location as long as it is accessible to the general public. Table 3 summarizes some common examples of both reasonable and unreasonable locations for application of the CO standards as identified in EPA guidelines.

Table 3. Applicability of the CO Standards

| Reasonable locations | Unreasonable locations |
| --- | --- |
| - All sidewalks where the general public has access on a continuous basis | - Median strips on roadways |
| - A vacant lot in which a facility is planned and in whose vicinity the general public would have access | - Locations within the right-of-way on limited access highways (e.g., freeways) |
| - Portions of a parking lot to which pedestrians have access continuously | - Within intersections or on crosswalks at intersections |
| - Property lines of all residences, hospitals, rest homes, schools, playgrounds, and the entrances and air intakes to all other buildings | - Tunnel approaches<br>- Within tollbooths |

Source: Environmental Protection Agency

This interpretation of the standards is apparently necessary because it is not possible to establish that no one would remain at a publicly accessible location for more than one or eight hours. Therefore, to ensure the protection of public health, the standards must be met at all such locations. If the standard were interpreted to apply to CO exposures for "typical" individuals traversing the same locations but not remaining for the requisite one or eight hour periods, peak CO levels greater than the ambient standards could be tolerated.

The Federal one-hour CO standard has never been exceeded at BAAQMD urban air monitoring stations. Because of the very localized nature of CO concentrations, it is likely that the one-hour standard has been exceeded in other locations. For example, a recent BAAQMD monitoring program conducted at San Francisco International Airport recorded one-hour average CO levels as high as 86 ppm. The Federal eight-hour standard (9 ppm) has been exceeded on numerous occasions and at several locations.

CARBON MONOXIDE CONTROL STRATEGIES

The actions identified in this plan element presume continued enforcement of State and Federal new vehicle emission standards. The actions include:

- implementation of a mandatory annual vehicle inspection and maintenance program
- implementation of a heavy duty gasoline truck exhaust catalyst retrofit program
- preferential parking for carpools
- transit service improvements
- additional ramp metering and high occupancy vehicle lanes on selected freeway segments
- implementation of expanded regional carpool and vanpool matching program
- implementation of a comprehensive system of bicycle paths and storage facilities
- collection of additional data to more accurately characterize CO problems at selected locations
- continuing analysis, evaluation, and control strategy development as new information is collected

All of the actions identified for carbon monoxide controls were adopted as part of the Bay Area's hydrocarbon control strategy in June 1978. They were subjected to detailed assessment required under the National Environmental Policy Act (NEPA) and an environmental impact report was prepared under the California Environmental Quality Act (CEQA) for the Environmental Management Plan (including the AQMP). No additional CEQA assessment is done for the carbon monoxide control strategies since no additional control programs are recommended at this time. Implementation of the recommended controls will provide reasonable further progress toward attaining the CO standard as required by the Clean Air Act (see Figure 3).

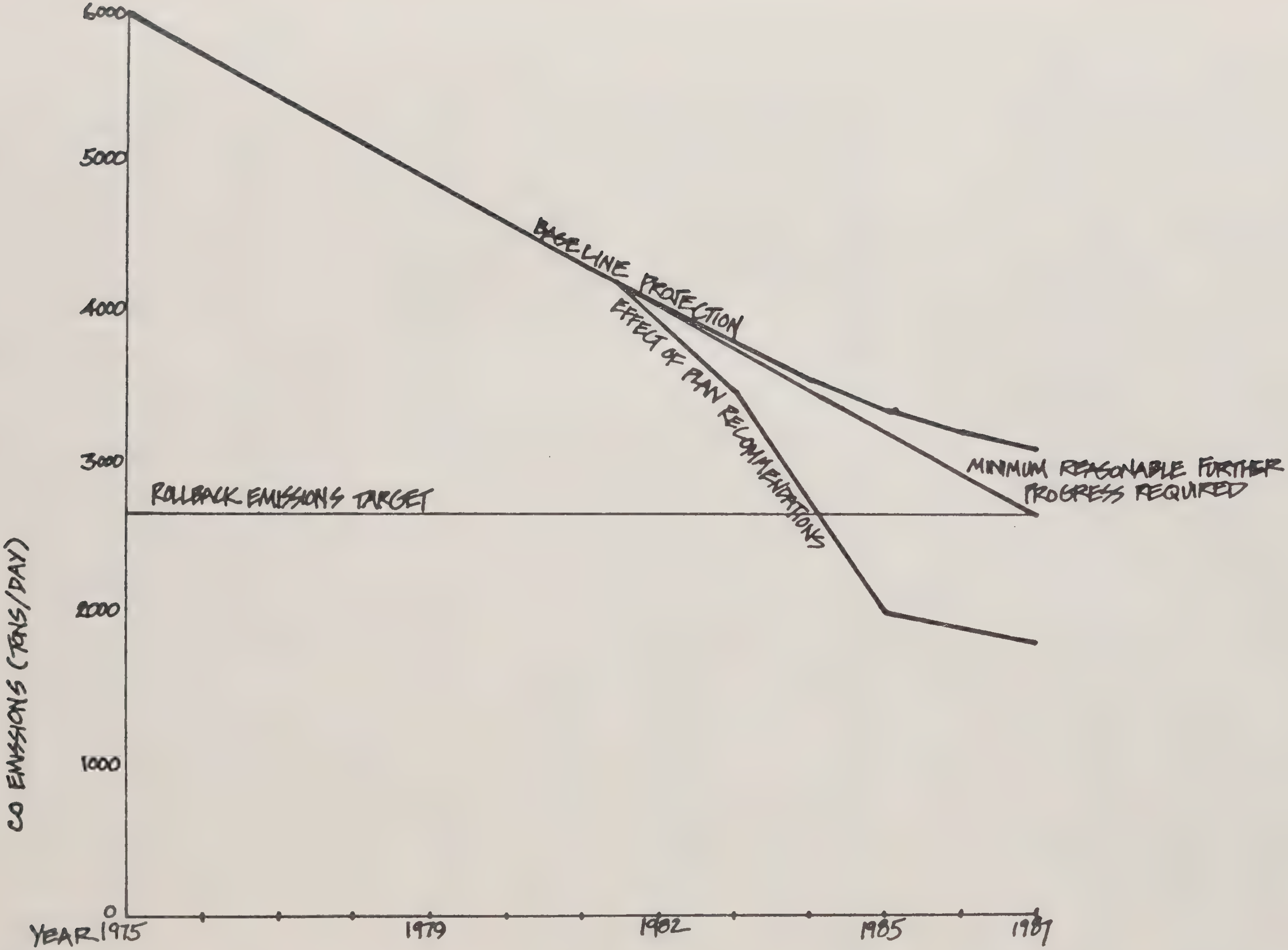



FIGURE 3

PROJECTED REASONABLE FURTHER PROGRESS TOWARD ATTAINMENT OF FEDERAL CARBON MONOXIDE STANDARDS. (BASED ON LINEAR ROLLBACK AND IMPLEMENTATION OF ALL RECOMMENDED CONTROL PROGRAMS.)

A crucial aspect of this plan element is the further characterization of CO problems in the region and continuing plan development as needed. The existing data on carbon monoxide do not provide a complete picture of the problem. The recommended actions will, according to existing data, result in attainment and maintenance of the CO standards. However, because of the recognized limitations of the existing data, it is likely that the problems are more severe than the data would suggest and that therefore additional control programs may be identified as necessary in subsequent plan updates. If further controls are recommended as part of this continuing planning process, they will be assessed under NEPA and CEQA. Further, because of lead time necessary to implement the most effective programs, an extension of the deadline for attaining the CO standards beyond 1982 will be requested. According to the current analysis, 1984 is the earliest date that attainment can be expected.

## THE NATURE OF PARTICULATE (TSP) PROBLEMS

Like carbon monoxide, particulate problems appear to be localized within the Bay Area, and are highly dependent on proximity to particulate sources. Unlike carbon monoxide, there are many different sources of particulate matter in the atmosphere. Depending on the specific location, the relative contribution of various sources to the particulate levels being measured may vary substantially. Four general types of particulate sources can be identified: (1) particulates emitted directly as a result of human activity (e.g., industrial emissions, motor vehicle exhaust); (2) particulates injected into the atmosphere as the result of natural factors and/or indirectly due to human activity, otherwise known as "fugitive dust" (e.g., dust blown from construction sites, dust from farming operations, dust from roadways kicked into the air by motor vehicle traffic); (3) particulates that are formed in the atmosphere from other gaseous pollutants, otherwise known as secondary aerosol; and (4) natural particulates (e.g., sea salt, windblown dust, pollen).

Ambient concentrations of TSP in the Bay Area exhibit a general pattern of low values near the coast, increasing with distance inland, particularly into dry, sheltered valleys. The highest particulate levels are typically recorded in the Santa Clara and Livermore Valleys. The Livermore monitoring station has recorded the most excesses.

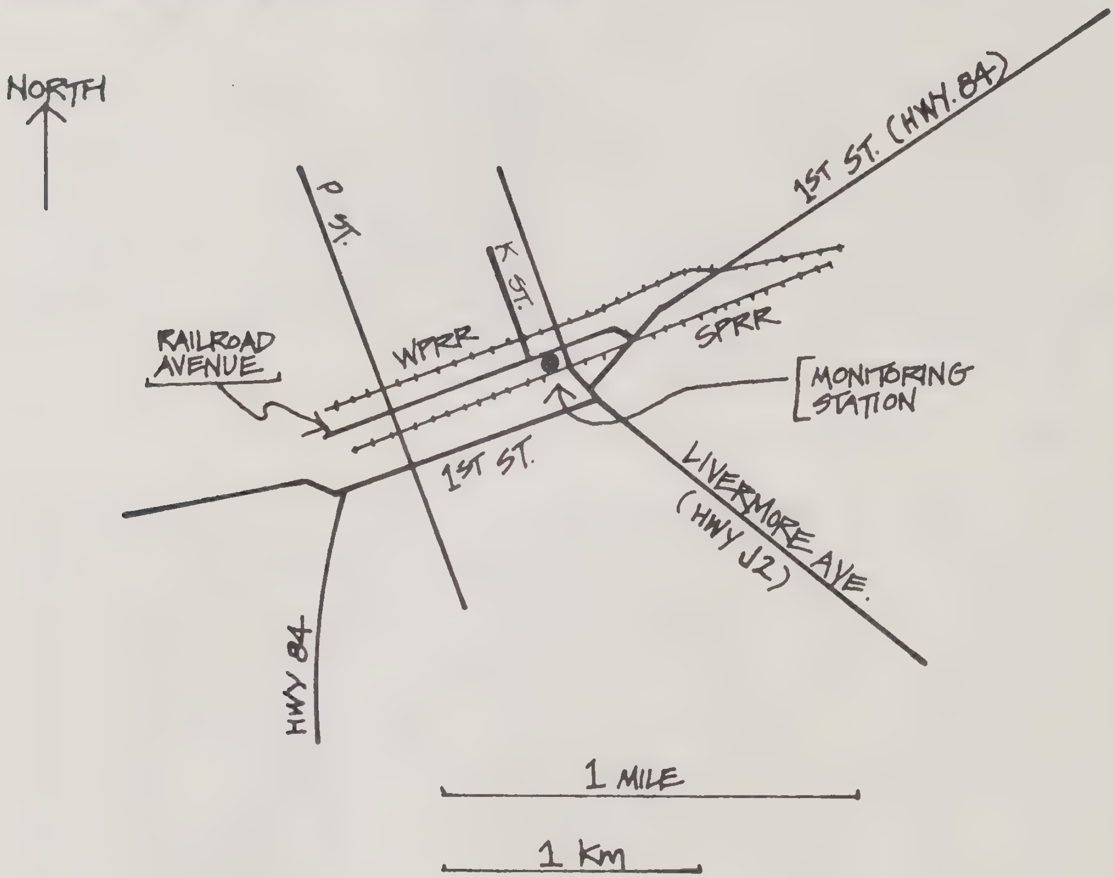
Alameda County has been designated a non-attainment area for total suspended particulate matter, based on the 80 $\mu g/m^3$ annual geometric mean concentration measured at the Livermore station in 1975. In addition, San Francisco, Contra Costa, Alameda, and Santa Clara Counties have been designated non-attainment for the Federal secondary standards. Because of the relatively high concentrations observed at the Livermore station, the site has been the subject of much study. Figure 4 illustrates the proximity of the site to a number of construction projects that were underway in 1975.

## MEETING TSP STANDARDS

Based on the recent monitoring record, it is expected that the Livermore station AGM will be below 75 $\mu g/m^3$ for the foreseeable future. The three

FIGURE 4

# LIVERMORE MONITORING SITE




CONSTRUCTION PROJECTS IN THE VICINITY OF THE STATION

| NO | DATES | DESCRIPTION |
|---|---|---|
| 1 | 7/75 - 12/76 | RAILROAD RELOCATION - MOVE SP TRACKS FROM SP RIGHT-OF-WAY TO WP ROADBED. |
| 2. | 6/74 - 3/76 | LIVERMORE AVENUE UNDERPASS. HIGHWAY GOING UNDER RAILROAD. |
| 3. | 6/74 - 2/76 | P STREET UNDERPASS, ROAD UNDER R.R |
| 4. | 74 - 75 | RELOCATION OF HIGHWAY 84, EARTH MOVING ALONG SP RIGHT OF WAY. |
| 5. | 11/74 - 9/75 | SHOPPING CENTER CONSTRUCTION AT RAILROAD AVENUE AND P STREET |
| 6. | 8/74<br>8/75<br>8/76 | RESURFACE RAILROAD AVENUE<br>"<br>" |
| 7. | 9/75 - 12/75 | BUILDING CONSTRUCTION, RR AVE & K STREET |

conditions which contributed to high TSP in 1975 and 1976 (construction, drought and extreme restrictive meteorology) are not expected to recur, especially simultaneously. The general composition of the Livermore TSP is known, with 35% soil-like particles as the largest fraction and 24% soot-organics as the second largest. Since neither of these is amenable to modeling at this time, we rely on the developing monitoring record to demonstrate attainment by 1978. The 1977 AGM was 68 by BAAQMD calculation and the 1978 AGM is 63 through July 1978.

Substantial reductions in the hydrocarbon inventory are expected as the oxidant plan is implemented, and the construction near the Livermore station has been completed. Thus both fugitive dust and organic components should be substantially reduced, though the reductions may not be quantified except through the monitoring record. After two clean years, 1977 and 1978, Alameda County may be redesignated by the ARB or EPA as an attainment area with respect to the national primary particulate standards.

The attainment of secondary standards in four counties presents a more difficult problem, where the solution will depend on control of fugitive dust. With winter rural inland background values of about 30 $\mu g/m^3$ with excursions to 100 $\mu g/m^3$, it is clear that the estimation and control of fugitive dust will be a demanding and critical task. It is clear that a useful calculation of fugitive emissions must depend on careful analysis of the existing data, and possibly the publication of new research. Even with agreement on emission factors, the fugitive emissions calculations will require collection and analysis of new kinds of data in the Bay Area: crop acreage, unpaved roads and areas, soil moisture, soil particle sizing, precipitation/evaporation indices, etc. This exercise may require several person-years of work and up to one calendar year to accomplish.

## BENEFITS AND COSTS OF THE PLAN

There are numerous benefits and costs associated with carrying out the plan. The major benefit will be clean, healthy air for the region. This will be especially important to children, elderly, and individuals with respiratory ailments. This plan will virtually eliminate people's exposure to oxidant levels in excess of the standard.

There are other benefits. Tens of millions of dollars will be saved annually from slower deterioration or aging of paints, clothing, rubber goods, and other products. Large savings are estimated for the agricultural industry in the Bay Area for products including grapes, spinach and flowers.

Implementing the plan would also mean less motor vehicle travel. This in turn would result in significant energy savings, reduced road maintenance costs and fewer traffic accidents.

There are direct and indirect costs related to the plan also. Private industry will be required to invest tens of millions of dollars annually for the available control technologies. The cars produced will have more sophisticated control equipment on them, and will no doubt be more expensive. For older cars, more repairs may be needed following the annual inspection and maintenance check up. Driving the private auto would be

somewhat more expensive. This should be partially offset, however, by fuel savings.

Overall, large uncertainties exist in the estimates of both the benefits and costs. In some instances, the projected effects will be overstated, and in other cases, they will be understated. A more detailed discussion of these anticipated effects and costs are provided in Sections K, M and R.

FUTURE PLANNING ACTIVITIES

Future planning activities will focus on developing detailed design specifications for each of the adopted control programs, implementing the programs, monitoring their effects, and resolving some key technical issues identified during the initial plan development effort. Significant findings from each of the activities will be published annually, and a revised plan based on the information gathered will be prepared for review and adoption in 1982.

Activities that are designed to follow up on the control programs adopted in this plan are necessary to ensure that the Bay Area continues to comply with the legal requirement for making "reasonable further progress" toward attainment of air quality standards. Immediate attention will be focused on developing detailed design specifications for each control program so that legally enforceable commitments for implementation can be secured, and the programs can be implemented as scheduled in the plan.

The key technical issues to be addressed include:

- The impact of Bay Area emissions on air pollution in neighboring areas - There is scattered evidence suggesting that elevated oxidant levels measured in areas adjoining the Bay Area are at times partially attributable to emissions from the Bay Area. It is further suspected that additional control of oxides of nitrogen emissions would reduce the Bay Area's impact on air quality in those areas while making it more difficult to attain the oxidant standard within the region. A computer modeling study of this problem will be undertaken to shed light on the issue.

- Characterization of localized carbon monoxide problems - Current monitoring locations for carbon monoxide are not considered to provide data on maximum CO levels experienced in the region, and therefore probably underestimate the magnitude of CO problems in the region. The current plan provides for attainment of CO standards based on existing data. In recognition of the limitations of the data the plan also calls for additional CO monitoring studies in known "hot spots," and subsequent development of additional control programs if found necessary. A pilot monitoring study is currently underway, and will be expanded to include all known CO problem areas in the Bay Area (San Jose, Sunnyvale, San Francisco, Oakland, and Vallejo). If these studies should indicate a need for development of additional control programs to attain CO standards, such programs will be developed in conjunction with the affected local jurisdictions.

- <u>Characterization of the particulate problems in terms of size and source origin categories</u> - To assess the effectiveness of further particulate controls to attain Federal secondary particulate standards, a variety of technical studies must be performed to characterize the origins of the particulate matter sampled in each problem location. Special emphasis will also be paid to the development of a fugitive dust inventory and the design and pilot testing of alternative fugitive dust control methods.

Several more detailed tasks are identified for completion in the next three years. A description of these tasks is contained in Section X of this chapter.

# Section-C

# BACKGROUND OF THE PLAN

The Federal Clean Air Act of 1970, and more recently the Clean Air Act Amendments of 1977, set forth a series of stringent requirements of air pollution control. Each state is required to prepare detailed state implementation plans demonstrating how specific air quality standards are to be met. These standards have been set to protect public health. In a similar but separate manner, Califonria has also set ambient air quality standards, again to protect public health. Under California law, ARB adopted standards are to be met as soon as it is reasonably possible.

Many California regions, including the Bay Area, have exceeded some or all of the Federal and State air quality standards. Thus, the need for a plan is clear.

THE GOAL

When the Bay Area's air quality planning process began, the Clean Air Act of 1970 was in effect. At that time it was clear that the requirements of the 1970 legislation could not be met, namely the attainment of Federal air quality standards by 1977 and maintenance thereafter. Anticipating that amendments to the Clean Air Act of 1970 were soon forthcoming, the Environmental Management Task Force (EMTF) adopted the following goal by resolution in early 1977:

> "The goal of the Air Quality Maintenance Plan is attainment and maintenance of Federal and State air quality standards as expeditiously as practicable."

In August of this year, Congress passed and the President signed into law the Clean Air Act Amendments of 1977. The new law, as anticipated, provides additional time for areas with severe air pollution problems to meet the previously prescribed air quality standards. California is now required to provide for the attainment of Fedreal air quality standards no later than December 31, 1982. The 1977 Amendments do provide in areas with especially severe oxidant and carbon monoxide problems (such as the Bay Region) that the deadline for meeting the Federal standards may be extended to as late as December 31, 1987. This extension can be granted only if all reasonably available control measures have been implemented. For example, a schedule for implementing a motor vehicle inspection and maintenance program is specifically required. In addition, the revised state implementation plan must show "reasonable further progress" and any new or modified stationary sources must operate at the "lowest achievable emission rate" for its industrial category.

## AIR QUALITY STANDARDS

As noted previously, two sets of ambient air quality standards exist in the Bay Area. The U.S. Environmental Protection Agency set Federal standards and the California Air Resources Board has set State standards. Both sets of standards are intended to protect public health from the adverse effects of air pollution. The standards have been summarized in Table 1.

Ambient air quality standards have always been controversial. They have been criticized both as being too permissive (not sufficiently protective of public health) and too stringent (or overly protective of public health). Because the medical research supporting air quality standards is always being updated, these standards are periodically reviewed. Since 1971, when the Federal air quality standards were set, these standards have remained unchanged. During the past six years, several reviews of the Federal standards have been conducted.

The 1977 Amendments require the following actions be taken regarding Federal air quality standards:

- Not later than December 31, 1980, and at five-year intervals thereafter, the Environmental Protection Agency shall thoroughly review the air quality standards and revise them as appropriate. Such reviews may be conducted earlier or more frequenlty than specified above. For example, the photochemical oxidant standard is currently under review by EPA.

- The reviews described are to be conducted by an independent scientific review committee with recommendations to the Environmental Protection Agency on both new standards and/or revisions of existing standards as appropriate.

The plan presented in this document assumes the Federal and State air quality standards shown in Table 1 are to be met. The control strategy implications for meeting Federal and State air quality standards are described in this chapter.

## LEGAL REQUIREMENTS

In 1976, the Environmental Protection Agency published regulations for the preparation, adoption, and submittal of state implementation plans to deal with long-term maintenance of Federal air quality standards. Basically, these regulations require the following tasks be conducted:

- Projection of emissions into the future

- Allocation of emissions according to estimated projections of location

- Calculation of air quality resulting from the future emission pattern

- Development of a control strategy to maintain the Federal air quality standards

- Adoption of regulations to make the control strategy enforceable

The above approach has generally been used in developing the plan. In some cases, it has not been possible to complete all of the tasks required. These instances are noted along with a discussion of the air quality issues raised. Section J discusses specific requirements set forth by the Clean Air Act of 1977.

## PREVIOUS PLANNING

Air pollution control programs, have been actively pursued in the Bay Area since the 1950s. However, the major impetus for formal air quality planning began with passage of the Clean Air Act of 1970. Under this Act, states were given primary responsibility for developing and submitting to EPA a state implementation plan which contained measures to meet Federal air quality standards. If a state failed to submit a plan which was acceptable, EPA was required to prepare such a plan.

In the San Francisco Bay Region, the California Air Resources Board directed the Bay Area Air Pollution Control District to prepare various air pollution control strategies as part of the initial state implementation plan. Based on these controls and others added by the California Air Resources Board, the State of California prepared and submitted its plan to the Environmental Protection Agency in 1972. The plan was found deficient. One of the deficiencies cited by the Environmental Protection Agency in the state implementation plan was the failure to include adequate control strategies for transportation related pollutants--in particular, carbon monoxide and photochemical oxidant.

Following a court decision on the plan's inadequacies, the Environmental Protection Agency directed California to submit a transportation control plan for the Bay Area to reduce auto-related pollutants. The purpose of the transportation controls was to reduce auto emissions to a level which would allow meeting air quality standards. Because of the severity of the oxidant and carbon monoxide problems, transportation control plans were really a misnomer for control strategies dealing with stationary and mobile sources.

The deadline for submitting the transportation control plan in the Bay Area was very short. Acting in response to a court order, the Environmental Protection Agency Administrator in March 1973 notified the Governor of California that a plan should be submitted by April 15, 1973. The tight deadlines, combined with the severe air pollution problems to be dealt with, led to California defaulting on its responsibility to prepare an "acceptable" transportation control plan and state implementation plan.

When California failed to submit a transportation control plan as requested, the Environmental Protection Agency promulgated its own in November 1973. The plan showed that a 97% reduction in travel in the Bay Area would be needed to meet the air quality standards. The Environmental Protection Agency plan included traffic controls, other mobile source emission controls and extensive stationary source controls. To achieve the 97% reduction in travel, limitations on gasoline sales or gas rationing, was proposed. While the Environmental Protection Agency expressed serious reservations about the feasibility of a gas rationing program, it stated the Clean Air Act left the Environmental Protection Agency Administrator with no other legal alternative but to include such a strategy.

Recognizing the unsatisfactory nature of the Environmental Protection Agency plan, the State exercised its option to prepare and substitute its own plan. In the Bay Area responsibility for development of a transportation control plan was delegated to the Metropolitan Transportation Commission. The plan was developed under the direction of the Metropolitan Transportation Commission Traffic Coordinating Council. Membership of this Council is structured to represent the diverse interests of the region.

The plan was completed in early 1975. It was adopted by the Metropolitan Transportation Commission as part of their regional transportation plan. Various transportation control strategies, short and long-terms, were presented in the transportation control plan with an analysis of their implications on air quality. Because the plan was unable to demonstrate meeting the air quality standards, it was not accepted by the California Air Resources Board. Transportation controls to reduce the amount of travel within the region decrease in effectiveness as motor vehicle emission controls become more effective. This fact contributed to the State failure to adopt these programs as part of its plan.

In summary, the current planning effort was intended to satisfy a number of requirements, including:

- Previous deficiencies of the transportation control plan and state implementation plan for meeting air quality standards;

- Federal regulations that strategies developed will show continued maintenance of air quality standards once attained; and

- Recently enacted requirements of the 1977 Clean Air Act for state implementation plan revisions to show attainment of air quality standards by 1982, or at the latest 1987.

## EXISTING AND PLANNED PROGRAMS

Many control programs for air pollution currently exist. More are scheduled to be implemented in coming years. Before an examination of potential solutions to our present and projected problems can be conducted, a thorough understanding is needed of existing and planned air pollution programs. These programs have been organized primarily according to implementing authority and/or responsibility.

### Stationary Source Emission controls

In the San Francisco Bay Region, the Bay Area Air Quality Management District (BAAQMD) has been empowered to control air pollution from stationary sources. Since its formation in 1955, the District has developed air pollution control programs for many categories of stationary sources.

To date the BAAQMD has enacted eight regulations, and six of these affect stationary sources. Some of them directly control air pollution by limiting the emissions of specific pollutants, either on a mass flow rate or concentration basis. Other regulations indirectly control pollutants by curtailing open burning, new source construction and expansion of existing stationary sources. Some sections deal specifically with emissions of odorous substances and others limit the density of smoke that may be emitted to the atmosphere. The regulations of the BAAQMP have been expanded and modified through the

years, and are generally acknowledged to be about the most stringent in the United States. A brief description of the present regulations follows.

Regulation One, adopted in March 1957, bans backyard trash burning and dump fires. It lists allowable types of fires and limits agricultural burning to favorable meteorology days designated "burn days" by the District.

Regulation Two, first adopted in May 1960, has eighteen different divisions. It includes controls on particulate matter (smoke particles and dust), sulfur compounds, lead, nitrogen oxides, and odorous substances from industrial and commercial sources. Permit and new source review requirements are also included in Regulation 2. The requirement for vapor recovery systems at service stations is part of the permit regulation.

The District's permit requirements, set out in Division 13 of Regulation Two, require anyone wishing to build or expand a source that emits air contaminants to first apply to the BAAPCD for a permit to build, and submit plans and specifications for evaluation by District engineers. Permits to build or modify will be denied if it is determined that the project would not meet any of the District's emission requirements or would cause any air quality standard to be exceeded in the vicinity of the proposed site. A second evaluation is required after the source is built before it can obtain a permit to operate. Division 13 also requires vapor recovery controls for service stations.

Regulation Three, originally promulgated in 1967, was developed to control emissions of organic compounds, in particular "reactive" organics which are relatively quick to react with nitrogen oxides in the atmosphere and form photochemical oxidant. Olefins, substituted aromatics, branched chain ketones and trichloroethylene are examples of reactive organic compounds controlled under this regulation. Regulation Three affects the formulation, storage, shipment and use of such materials as solvents, paint, gasoline and ink.

Regulation Four, June 1971, does not deal with stationary source controls. Now obsolete, it required installation of crankcase emission control devices on certain automobiles.

Regulation Five, adopted March 21, 1974, defines three levels of air pollution episodes and specifies actions to be taken by the Air Pollution Control Officer. Certain corrective control measures are invoked to discourage further buildup of contaminants in the atmosphere. Included in Regulation 5 is a requirement that source operators submit, in advance, standby plans for reducing emissions during air pollution episodes.

Regulation Six, 1974, does not affect stationary sources. It gives members of the BAAPCD vehicle patrol authority to arrest individuals observed to be violating those provisions of the vehicle code relating to automobile emissions.

Regulation Seven, December 1974, sets emission standards for new or modified sources of air pollution, following EPA guidelines. These sources include fossil fuel power plants, larger incinerators, cement plants, acid plants, refineries, smelters and steel plants.

Regulation Eight, December 1974, establishes limits for the emission of asbestos, beryllium and mercury, defined as hazardous pollutants by the EPA. Sources of asbestos are allowed no visible emissions. The beryllium standard limits emissions to not more than 10 grams per 24-hour period. For mercury the limit is no more than 23 grams/24 hours.

Because of the historical development process, the present system of regulations has become somewhat unwieldy. A complete reorganization is presently being studied and is expected to make the regulations easier to understand and apply.

## Motor Vehicle Emission Controls

The California Air Resources Board (CARB) is the State agency responsible for coordinating both State and Federal air pollution control programs in California. This responsibility includes regulation of pollutant emissions from motor vehicles and coordination of local programs for stationary source control.

Due to the severity of air pollution problems in California, the federal government gives the State the option of enforcing motor vehicle emission standards which are more stringent than federal emission standards. Thus, while the Environmental Protection Agency takes primary responsibility for motor vehicle emissions control, the CARB can and has adopted and enforced emission standards more stringent than required at the Federal level. This section summarizes CARB responsibilities for mobile source control.

The CARB currently has regulations which control emissions form light, medium and heavy duty gasoline powered vehicles, diesel powered trucks and buses, and motorcycles. In addition, the CARB has in effect various regulations and procedures to ensure that emission standards are met. Table 4 presents current vehicle emission standards adopted by the CARB. Recently enacted federal statues are also presented for comparison.

## Transportation Controls

The following transportation control projects are currently operating in the San Francisco Bay Area. Some were required as elements of the transportation control plan, while others are the result of regional transportation planning.

1. Ramp and Mainline Metering:

   I-580 - Beaumont Avenue eastbound on-ramp in Oakland;

   I-280 - 5 northbound on-ramps between Winchester Road and Route 85 in San Jose. Wolfe Road on-ramp provides bypass for buses and carpools of 2 or more.

   Rt. 101 - 5 northbound on-ramps between Capitol Avenue and Route 17 in Santa Clara County;

   Rt. 17 - 23 northbound and southbound on-ramps between Route 9 and Route 101 in Santa Clara County;

   Bay Bridge - In March 1974, an overhead metering system was installed just beyond the toll plaza at a cost of $350,000. This system has maximized the operational efficiency of the bridge.

TABLE 4

# NEW VEHICLE STANDARDS SUMMARY - PASSENGER CARS

Increasingly stringent standards for new passenger cars [1] have been imposed by State and Federal law. The following regulations apply to gasoline powered passenger cars only through 1979 and to gasoline and diesel powered cars beginning in 1980.

| YEAR | STANDARD | TEST PROCEDURE | HYDRO-CARBONS | CARBON MONOXIDE | OXIDES OF NITROGEN |
|---|---|---|---|---|---|
| Prior to Controls | None | 7-mode | 850 ppm | 3.4% | 1000 ppm |
| | | 7-mode | 11 gm/mi | 80 gm/mi | 4 gm/mi |
| | | CVS-75 | 8.8 gm/mi | 87.0 gm/mi | 3.6 gm/mi |
| 1966-67 | Calif. | 7-mode | 275 ppm | 1.5% | no std. |
| 1968-69 | Calif. or Federal | 7-mode | | | |
| | | 50-100 CID | 410 ppm | 2.3% | no std. |
| | | 101-140CID | 350 ppm | 2.0% | no std. |
| | | over-140CID | 275 ppm | 1.5% | no std. |
| 1970 | Calif. & Federal | 7-mode | 2.2 gm/mi | 23 gm/mi | no std. |
| 1971 | Calif. | 7-mode | 2.2 gm/mi | 23 gm/mi | 4.0 gm/mi |
| | Federal | 7-mode | 2.2 gm/mi | 23 gm/mi | no std. |
| 1972 | Calif. | 7-mode or | 1.5 gm/mi | 23 gm/mi | 3.0 gm/mi |
| | | CVS-72 | 3.2 gm/mi | 39 gm/mi | 3.2 gm/mi (+ |
| | Federal | CVS-72 | 3.4 gm/mi | 39 gm/mi | no std. |
| 1973 | Calif. | CVS-72 | 3.2 gm/mi | 39 gm/mi | 3.0 gm/mi |
| | Federal | CVS-72 | 3.4 gm/mi | 39 gm/mi | 3.0 gm/mi |
| 1974 | Calif. | CVS-72 | 3.2 gm/mi | 39 gm/mi | 2.0 gm/mi |
| | Federal | CVS-72 | 3.4 gm/mi | 39 gm/mi | 3.0 gm/mi |
| 1975 | Calif. | CVS-75 | 0.9 gm/mi (2) | 9.0 gm/mi | 2.0 gm/mi |
| | Federal | CVS-75 | 1.5 gm/mi | 15 gm/mi | 3.1 gm/mi |
| 1976 | Calif. | CVS-75 | 0.9 gm/mi (2) | 9.0 gm/mi | 2.0 gm/mi |
| | Federal | CVS-75 | 1.5 gm/mi | 15 gm/mi | 3.1 gm/mi |
| 1977 | Calif. | CVS-75 | 0.41 gm/mi | 9.0 gm/mi | 1.5 gm/mi |
| | Federal | CVS-75 | 1.5 gm/mi | 15 gm/mi | 2.0 gm/mi |

Source: Air Resources Board, January 25, 1978

| YEAR | STANDARD | TEST PROCEDURE | HYDRO-CARBONS | CARBON MONOXIDE | OXIDES OF NITROGEN |
|---|---|---|---|---|---|
| 1978 | Calif. | CVS-75 | 0.41 gm/mi | 9.0 gm/mi | 1.5 gm/mi |
| | Federal | CVS-75 | 1.5 gm/mi | 15 gm/mi | 2.0 gm/mi |
| 1979 | Calif. | CVS-75 | 0.41 gm/mi | 9.0 gm/mi | 1.5 gm/mi |
| | Federal | CVS-75 | 1.5 gm/mi | 15 gm/mi | 2.0 gm/mi |
| 1980 | Calif. | CVS-75 | 0.41gm/mi(3) | 9.0 gm/mi | 1.0gm/mi(1.5 gm/mi) |
| | Federal | CVS-75 | 0.41gm/mi | 7.0 gm/mi | 2.0 gm/mi |
| 1981 | (4)Calif.(A) | CVS-75 | 0.41 gm/mi | 3.4 gm/mi | 1.0 gm/mi(1.5 gm/mi) |
| | Calif.(B) | CVS-75 | 0.41 gm/mi | 7.0 gm/mi | 0.7 gm/mi |
| | Federal | CVS-75 | (5)0.41 gm/mi | 3.4 gm/mi | 1.0 gm/mi |
| 1982 | (4)Calif.(A) | CVS-75 | 0.41 gm/mi | 7.0 gm/mi | 0.4gm/mi(1.0gm/mi) |
| | Calif.(B) | CVS-75 | 0.41 gm/mi | 7.0 gm/mi | 0.7 gm/mi |
| | Federal | CVS-75 | (5)0.41 gm/mi | 3.4 gm/mi | 1.0 gm/mi |
| 1983 | Calif. | CVS-75 | 0.41 gm/mi | 7.0 gm/mi | 0.4gm/mi(1.0gm/mi) |
| | Federal | CVS-75 | 0.41 gm/mi | 3.4 gm/mi | 1.0 gm/mi |

+ Hot 7-mode test

1. Passenger car as defined in Title 13 of the California Administrative Code means any motor vehicle designed primarily for transportation of persons having a capacity of twelve persons or less.
2. Hydrocarbon emissions from 1975-76 limited production vehicles may not exceed 1.5 gm/mi.
3. Compliance with non-methane standard of 0.39 gm/mi is an acceptable alternative to the 0.41 gm/mi total hydrocarbon standard.
4. Manufacturer must choose one option (A or B) for the 1981-82 model years.
5. Federal CO standard can be waived to 7.0 for 1981-82 by administrator after public hearing.
6. Values in parenthesis are the standards which must be met by manufacturers choosing to certify their vehicles for 100,000 miles instead of the normal 50,000 mile distance.

Effective 1978, evaporative emission standards are 6 grams per SHED test for 1978-79 model year and 2 grams per SHED test for 1980 and later.

gm/mi - grams per mile
CVS-72 - a Constant Volume Sample cold start test.
CVS-75 - a Constant Volume Sample Test which includes hot & cold starts.
7-mode - 137 second driving cycle test.
ppm- parts per million
SHED Test - Sealed Housing Evaporative Determination for the testing of motor vehicle vapor recovery systems.

## NEW VEHICLE STANDARDS SUMMARY - LIGHT DUTY TRUCKS

Increasingly stringent standards for Light-Duty Trucks[(1)] are imposed by State and Federal Law. The following is a summary of those regulations.

| YEAR | STANDARD | TEST PROCEDURE | HYDRO-CARBONS | CARBON MONOXIDE | OXIDES OF NITROGEN |
|---|---|---|---|---|---|
| 1966-67 | Calif. | 7-mode | 275 ppm | 1.5% | no std. |
| 1968-69 | Calif. or Federal | 7-mode | 410 ppm | 2.3% | no std. |
| | | 50-100 CID | 350 ppm | 2.0% | no std. |
| | | 101-140CID | 350 ppm | 2.0% | no std. |
| | | over-140CID | 275 ppm | 1.5% | no std. |
| 1970 | Calif. & Federal | 7-mode | 2.2 gm/mi | 23 gm/mi | no std. |
| 1971 | Calif. | 7-mode | 2.2 gm/mi | 23 gm/mi | 4.0 gm/mi |
| | Federal | 7-mode | 2.2 gm/mi | 23 gm/mi | no std. |
| 1972 | Calif. | 7-mode or | 1.5 gm.mi | 23 gm/mi | 3.0 gm/mi |
| | | CVS-72 | 3.2 gm/mi | 39 gm/mi | 3.2 gm/mi |
| | Federal | CVS-72 | 3.4 gm/mi | 39 gm/mi | no std. |
| 1973 | Calif. | CVS-72 | 3.2 gm/mi | 39 gm/mi | 3.0 gm/mi |
| | Federal | CVS-72 | 3.4 gm/mi | 39 gm/mi | 3.0 gm/mi |
| 1974 | Calif. | CVS-72 | 3.2 gm/mi | 39 gm/mi | 2.0 gm/mi |
| | Federal | CVS-72 | 3.4 gm/mi | 39 gm/mi | 3.0 gm/mi |
| 1975 | Calif. | CVS-75 | 2.0 gm/mi | 20 gm/mi | 2.0 gm/mi |
| | Federal | CVS-75 | 2.0 gm/mi | 20 gm/mi | 3.1 gm/mi |
| 1976 | Calif. | CVS-75 | 0.9 gm/mi | 17 gm/mi | 2.0 gm/mi |
| | Federal | CVS-75 | 2.0 gm/mi | 20 gm/mi | 3.1 gm/mi |
| 1977 | Calif. | CVS-75 | 0.9 gm/mi | 17 gm/mi | 2.0 gm/mi |
| | Federal | CVS-75 | 2.0 gm/mi | 20 gm/mi | 3.1 gm/mi |

TABLE 4 (continued)

LIGHT DUTY TRUCKS

| YEAR | STANDARD | TEST PROCEDURE | HYDRO-CARBONS | CARBON MONOXIDE | OXIDES OF NITROGEN |
|---|---|---|---|---|---|
| 1978(2) | Calif. | CVS-75 | 0.9 gm/mi | 17 gm/mi | 2.0 gm/mi |
| | Federal | CVS-75 | 2.0 gm/mi | 20 gm/mi | 3.1 gm/mi |
| 1979 | Calif.(3) | CVS-75 | 0.41 gm/mi | 9.0 gm/mi | 1.5 gm/mi |
| | Calif.(4) | CVS-75 | 0.50 gm/mi | 9.0 gm/mi | 2.0 gm/mi |
| 1979 (5) | Federal & later | CVS-75 | 1.7 gm/mi | 18 gm/mi | 2.3 gm/mi |
| 1980 | Calif. (3) | CVS-75 | 0.41 gm/mi(6) | 9.0 gm/mi | 1.5gm/mi (1.0gm/mi |
| | Calif. (4) | CVS-75 | 0.50 gm/mi | 9.0 gm/mi | 2.0gm/mi (2.3gm/m |
| 1981-82 | Calif. (3) | CVS-75 | 0.41 gm/mi | 9.0 gm/mi | 1.0gm/mi (1.5gm/m |
| | Calif. (4) | CVS-75 | 0.50 gm/mi | 9.0 gm/mi | 1.5 gm/mi (2.0gm/m |
| 1983 & later | Calif. (3) | CVS-75 | 0.41 gm/mi | 9.0 gm/mi | 0.4gm/mi (1.0gm/mi |
| | Calif. (4) | CVS-75 | 0.50 gm/mi | 9.0 gm/mi | 1.0gm/mi (1.5gm/mi) |

\+ Hot 7-mode test

1. Light duty trucks as defined by Title 13 of the California Administrative Code means any motor vehicle rated at 6000 lbs. GVW or less which is designed primarily for purposes of transportation of property or is a derivative of such vehicle, or is available with special features enabling off-street or off-highway operation and use.
2. The standards apply to both gasoline and diesel powered vehicles for 1978 and later years.
3. 0-3999 pounds equivalent inertia weight.
4. 4000-6000 pounds equivalent inertia weight.
5. Effective 1979, Federal LDT classification will be extended to 8500 GVW.
6. Compliance with non-methane standard of 0.39 gm/mi is an acceptable alternative to California's 0.41 gm/mi standard.
7. Values in parenthesis give manufacturers the option to certify their vehicles at stricter standards for 50,000 miles or less stringent standards for 100,000 miles.

Effective 1978, evaporative emission standards are 6 grams per SHED test for 1978-79 model years and 2 grams per SHED test for 1980 and later.

gm/mi - grams per mile   ppm- parts per million

7-mode - 137 second driving cycle test

CVS-72 - a Constant Volume Sample cold start test.

CVS-75 - a Constant Volume Sample Test which includes hot & cold starts.

## NEW VEHICLE STANDARDS SUMMARY MEDIUM DUTY VEHICLES

Increasingly stringent standards for medium duty vehicles[1] have been imposed by State and Federal law. The following is a summary of the regulations starting with the 1969 model year.

| YEAR | STANDARD | TEST PROCEDURE | HYDRO-CARBON | CARBON MONOXIDE | OXIDES OF NITROGEN (7) |
|---|---|---|---|---|---|
| 1969-77 | Calif. | SEE HEAVY DUTY STANDARD FOR 1969-1977 | | | |
| 1973-78 | Federal | SEE HEAVY DUTY STANDARD FOR 1973-1978 | | | |
| 1978 (2) | Calif. | CVS-75 | 0.9 gm/mi | 17 gm/mi | 2.3 gm/mi |
| 1979 | Calif. | CVS-75 | 0.9 gm/mi | 17 gm/mi | 2.3 gm/mi |
| | Federal | SEE LIGHT-DUTY TRUCK STANDARDS FOR 1979 and LATER | | | |
| 1980 | Calif. | CVS-75 | 0.9 gm.mi | 17 gm/mi | 2.3 gm/mi |
| 1981-82 | Calif.(3) | CVS-75 (6) | 0.41 gm/mi | 9.0 gm/mi | 1.0gm/mi (1.5gm/ |
| | Calif.(4) | CVS-75 | 0.50 gm/mi | 9.0 gm/mi | 1.5gm/mi (2.0gm/ |
| | Calif.(5) | CVS-75 | 0.60 gm/mi | 9.0 gm/mi | 2.0gm/mi (2.3gm/ |
| 1983 & later | Calif.(3) | CVS-75 | 0.41 gm/mi | 9.0 gm/mi | 0.4gm/mi (1.0gm/m |
| | Calif.(4) | CVS-75 | 0.50 gm/mi | 9.0 gm/mi | 1.0gm/mi (1.5gm/m |
| | Calif.(5) | CVS-75 | 0.60 gm/mi | 9.0 gm/mi | 1.5gm/mi (2.0gm/m |

1. Medium duty vehicles as defined in Title 13 of the California Administrative Code means any heavy-duty vehicle having a manufacturers' GVW rating of 8500 pounds or less (Manufacturers may elect to certify medium-duty vehicles up to 10,000 lbs GVW).
2. The standards apply to both gasoline and diesel powered vehicles for 1978 & later years.
3. 0-3999 equivalent inertia weight.
4. 4000-6000 equivalent inertia weight.
5. 6001-8500 equivalent inertia weight.
6. Compliance with non-methane standard 0.39 gm/mi is an acceptable alternative to California's 0.41 gm/mi standard.
7. Values in parenthesis give manufacturers option to certify their vehicles at the stricter standard for 50,000 miles or the less stringent standard for 100,000 miles.

Effective 1978, evaporative emission standards are 6 grams per SHED test for 1978-79 model years and 2 grams per SHED test for 1980 and later.
gm/mi - grams per mile
CVS-75 - a Constant Volume Sample test which includes hot & cold starts.

(TABLE 4 (continued)

## NEW VEHICLE STANDARDS SUMMARY - MOTORCYCLES

The following is a summary of motorcycle[(1)] standards adopted by both the Air Resources Board and the Federal Environmental Protection Agency.

| MODEL YEAR | STANDARD | DISPLACEMENT[(2)] | HYDROCARBONS | CARBON MONOXIDE |
|---|---|---|---|---|
| 1978-79 | Calif. & Federal | 50-169<br>170-749<br>750 & larger | 5.0 gm/km<br>5.0 +0.0155gm/km (D-170) (3)<br>14 gm/km | 17 gm/km<br>17 gm/km<br>17 gm/km |
| 1980-81 | Calif. | All 50 & Larger | 5.0 gm/km | 12 gm/km |
| 1980 & Later | Federal | All 50 & larger | 5.0 gm/km | 12 gm/km |
| 1982 & later | Calif. | All 50 & larger | 1.0 gm/km | 12 gm/km |

1. Any motor vehicle other than a tractor having a seat or saddle for the use of the rider and designed to travel on not more than three wheels in contact with the ground and weighing less than 1500 pounds, except that four wheels may be in contact with the ground when two of the wheels function as a sidecar.
2. Displacement shown in cubic centimeters.
3. Motorcycle Hydrocarbon Formula:
   170 cc to less than 300 cc 5.0 + 0.0155 (D-170)
   i.e., 300 cc - 170 cc = 130 cc X 0.0155 + 2.0150 + 5.0 = 7.01 gm/km standard.

gm/km - grams per kilometer

TABLE 4 (continued)

## NEW VEHICLE STANDARDS SUMMARY - HEAVY DUTY VEHICLES (DIESEL (1) AND GASOLINE)

Increasingly stringent standards for new heavy duty vehicles[2] have been imposed by State and Federal law. The following is a summary of the regulations starting with the 1969 model year.

| YEAR | STANDARD | HYDRO-CARBONS | CARBON MONOXIDE | OXIDES OF NITROGEN | HYDROCARBONS & OXIDES OF NITROGEN |
|---|---|---|---|---|---|
| 1969-71 (3) | Calif. | 275 ppm | 1.5% | - | - |
| 1972 | Calif. | 180 ppm | 1.0% | - | - |
| 1973-74 | Calif. | - | 40 gm/BHP hr | - | 16 gm/BHP hr |
| 1973-78 | Federal | - | 40 gm/BHP hr | - | 16 gm/BHP hr |
| 1975-76 | Calif. | - | 30 gm/BHP hr | - | 10 gm/BHP hr |
| 1977-78 | Calif. or | - | 25 gm/BHP hr | | 5 gm/BHP hr |
| | Calif. | 1.0 gm/BHP hr | 25 gm/BHP hr | 7.5 gm/BHP | - |
| 1979(4) | Calif. or | 1.5 gmBHP hr | 25 gm/BHP hr | 7.5 gm/BHP hr | |
| | Calif. | | 25 gm/BHP hr | - | 5 gm/BHP hr |
| 1979 & later | Federal or | 1.5 gm/BHP hr | 25 gm/BHP hr | - | 10 gm/BHP hr |
| | Federal | - | 25 gm/BHP hr | - | 5 gm/BHP hr |
| 1980-82 | Calif. or | 1.0 gm/BHP hr | 25 gm/BHP hr | - | 6.0 gm/BHP hr |
| | Calif. | - | 25 gm/BHP hr | - | 5 gm/BHP hr |
| 1983 & later | Calif. | 0.5 gm/BHP hr | 25 gm/BHP hr | - | 4.5 gm/BHP hr |

1. The diesel standard was not effective in California until January 1, 1973 and nationwide January 1, 1974.

2. Any motor vehicle having a manufacturer's GVW rating of over 6000 pounds except a passenger car.

3. Applies to vehicles manufactured on or after January 1, 1969.
4. Use of flame ionization detector in 1979 and later years will result in higher HC readings than the non-dispersive infra-red instrumentation currently in use. For 1979 only, California's HC standard is 1.0 gm/BHP hr and the Federal standard 1.1 gm/BHP hr for gasoline engines using the non-dispersive infra-red instrumentation.

gm/BHP hr - grams per brake horsepower hour

The following project will be constructed soon:

Rt. 101 - 5 northbound on-ramps between Route 17 and Fair Oaks Boulevard in Santa Clara County:

2. Preferential Bus/Carpool Lanes on Freeways:

Rt. 101 - Marin County Exclusive Bus Lanes. In 1972, a 3.9 mile northbound contra-flow exclusive bus lane was opened just north of the Golden Gate Bridge for use during the period 4 to 7 p.m. Approximately 100 buses use the lane, carrying about 4500 persons. In 1974 the project was extended north an additional 3.8 miles when concurrent-flow bus lanes were opened in both directions. Carpools were later allowed to use these lanes.

Rt. 280 - In October 1975, a two mile bus/carpool lane was opened on southbound I-280 in San Francisco from Sixth Street to approximately one-half mile south of Army Street. Approximately 200 carpools and 12 buses use this lane during the evening peak.

Rt. 580 - A bus/carpool lane is open through the Dublin Canyon. A study of the feasibility of extending this to the Bay Bridge is underway.

S.F. - In San Francisco bus lanes are in operation on Post and Sutter Streets between Van Ness and Taylor. Approximately 60 buses use these lanes during the peak periods. Muni has reported improved schedule adherence. A bus lane has also opened along Mission Street.

3. Toll Incentives:

Bay Bridge - In December 1971, with flow carpool and bus lanes were opened at the westbound approach of the toll plaza. In 1975 carpool tolls were eliminated. During the 6 to 9 a.m. peak period, 430 buses and 2,200 carpools use the priority lane.

San Mateo-Hayward and Dumbarton Bridges - Toll free preferential lanes for buses and carpools were opened on both these bridges. Approximately 52 carpools and 40 buses use these lanes during commute periods.

Golden Gate Bridge - The Golden Gate Bridge District began allowing carpools to use the bridge toll-free in 1976. Approximately 1100 carpools use this lane.

Toll Revenues - AB 664 gave the Metropolitan Transportation Commission authority over the level and use of tolls on the trans-bay bridges. The Commission has recently raised the tolls and is using the excess revenue for transit.

4. Carpool Matching Program:

RIDES - is a program operated by Caltrans District 04 to promote carpooling in the San Francisco Bay Area. A non-profit corporation funded by Caltrans, the Federal Energy Administration and Metropolitan Transportation Commission, has been established to expand this program. A survey conducted in 1975 indicated that approximately 5000 persons had formed carpools as a result of the program.

5. Improvement of Transit Service:

AC/BART - Coordinated Fare - The AC/BART transfer system provides for free transfers from BART to AC.

MUNI/BART Coordinated Fare - The MUNI/BART transfer system provides two tickets for MUNI bus rides for 25¢, a savings of one-half the full regular fare.

Santa Clara - Santa Clara Transit District was formed in 1972. Operations commenced in 1975 with 233 buses. The District also operated 9 buses for "Commute Specials"--these are used by some of the corporations.

Bus Pre-emption - A bus pre-emption system is to be installed along a portion of Almaden Expressway. Twelve signalized intersections are involved. The traffic signal equipment is under construction.

San Mateo County - San Mateo Transit District was formed in 1974 and operations commenced in July 1976. Two hundred buses provide service to and within most cities in San Mateo County including a connecting service between most cities in San Mateo County including a connecting service between the Daly City BART station and San Francisco Airport. Buses also serve Southern Pacific Stations in the county.

Marin County - In 1970 Golden Gate Transit introduced a new ferry service between Sausalito and San Francisco. Additional service was added in December 1976 between Larkspur and San Francisco.

Napa County - Napa County introduced a Dial-A-Ride system which is designed to provide local transit service in three communities: St. Helena, Calistoga and Napa. The service is provided using one bus.

Sonoma - Mini-bus operates in Sebastopol. Transit service in Santa Rosa is provided by 13 buses, which operate approximately 40 minutes apart.

Solano - In August 1975, the City of Fairfield implemented a Dial-A-Ride program using 5 vans. The service area is seven square miles with a population of 40,000.

AC Transit - AC Transit now provides contract city services in Concord, Pleasant Hill, and Moraga/Orinda. AC Transit also connects with Santa Clara County Transit District buses at Fremont BART station.

6. Preferential Parking:

San Francisco - Caltrans is in the process of leasing 4 state parking lots for carpool use. There would be 580 stalls available, open only to carpools of 3 or more. The fee would be not more than $10/month.

The experience with transportation programs is valuable. The carpool incentives seem to be successful. The transit additions are also rather significant, but the problems of financing are becoming critical.

Land Use Management/Development Controls

This term as traditionally used is a misnomer since measures dealing with land use, or land development, include a wide array of non-regulatory devices from the general plan of cities and counties to the service commitments of special districts. The more current and more widely used term "growth management" also means many different things in many different jurisdictions. Hence, in the ABAG Environmental Management Plan we use the terms "development policy" or "development strategy" to signify the land development objective sought, and the term "policy instruments" to mean the measure or tools of implementation.

*Land Development Policy As Currently Carried Out in the Bay Region.* The implementation of land development policy includes the wide array of things local governments are doing to accommodate the growth as they individually forsee it. Development policy in each locality is a function of what local governments--cities, counties, and service districts--are doing with their legal and fiscal tools to regulate or manage land development. It is also how they support developments with essential urban services such as sewers, water, and roads. Information on the current operating policies of local service providing and regulatory agencies was inventoried in ABAG's 1976 Local Development Policy Survey.

Development policy in local jurisdictions of the Bay Region means more than the general plans of cities or counties. The general plans and their zoning counterparts have been supplemented by capital improvement programs, special tax programs (e.g. Williamson Act Agricultural Preserves), specialized regulations in hazardous areas (e.g., slopes and flood plains), building permit allocation programs, and other programs. In some cases cooperative programs are in effect among cities, counties, and special districts to apply their individual policy instruments jointly to accomplish common development and service objectives.

*ABAG Series 3 Projections of Population, Employment and Land Use*. ABAG has used the inventory of local development policy as an important part of its Series 3 projections. The projections indicate what the short and long term changes are likely to be in the region if current local land development policy continues unchanged to 2000.

The Series 3 Projections account specifically for a wide array of local growth management programs. This was accomplished by a three phase survey conducted jointly by ABAG and the nine Bay Region counties. The ABAG 1976 Local Development Policy Survey contacted almost 400 local agencies including about 200 city agencies, 73 county agencies, and 125 independent special districts. Seventy-seven of the Bay Region's 93 cities responded along with 52 county agencies and 59 independent special districts. The results from the mail-back questionnaire were used to identify the key policies and policy instruments for in-depth examination in subsequent interviews.

Table 5 summarizes the results of the questionnaire survey. It presents policy instruments now in use to support development, constrain development, or both. On the basis of the number of jurisdictions using them, without regard to the size of the jurisdictions, the following general conclusions are noted:

a) Among development supporting instruments, assessment districts, redevelopment programs, and capital improvement programs for transportation, sewer, and water systems are the most common. Redevelopment incentives such as tax incentives or other special land reserves with service commitments are relatively rare but do exist as precedents for more widespread application in the region.

b) Among development constraining instruments open space zoning (and easements), public land acquisition, sewer connection limits and zoning moratoria are most prevalent; numerically transportation access limits, building permit moratoria, and prime agricultural land preserves are of secondary importance.

c) In the category of instruments that can be used to constrain or support development, the LAFCO spheres of influence dominate (see summary below).

*Implications of Regional Growth on Current Development Policy*. The implications of regional growth on current development policy are documented at length in the ABAG report on the Series 3 Projections. In summary, development policies concerning industrial growth are out of balance with those related to residential growth. Industrial land reserves far exceed the projected need to 1990. Residential land reserves based on service commitments and regulations are insufficient for the apparent need beyond 1990, assuming the highest probable regional growth trend; and insufficient in some areas even assuming the lowest probable regional growth trend.

These projected trends indicate the importance of development timing and how timing controls are important in developing regional land use alternatives for air quality improvements.

Table 5. Summary of Land Development Policies in Effect - Bay Region 1975

| Land Development Policy Instruments (In rank order by frequency regionwide within group) | Number of Jurisdictions Using: Total Active | Prior to 1970 | 1970 to 1975 | Expect by 1977 |
|---|---|---|---|---|
| **Group 1 Supporting Development** | | | | |
| Assessment (Improvement) Districts | 34 | 30 | 4 | 1 |
| Public Assisted Housing Programs | 25 | 12 | 13 | 2 |
| Redevelopment Programs | 15 | 7 | 8 | 8 |
| Transportation Extension C.I.P. | 21 | 16 | 5 | 4 |
| Sewer Extension Capital Improvement Program | 14 | 10 | 4 | 5 |
| Public Housing Programs | 9 | 6 | 3 | 1 |
| Water Extension Capital Improvement Program | 8 | 8 | 0 | 1 |
| Low Income Housing Program | 8 | 3 | 5 | 6 |
| Special Service Commitments | 6 | 5 | 1 | 2 |
| Sale of Public Land | 6 | 5 | 1 | 0 |
| Industrial/Commercial Land Reserve (other than zoning) | 0 | 0 | 0 | 3 |
| **Group 2 Neutral or Mixed** (used to support or constrain Development) | | | | |
| City Spheres of Influence (by LAFCO) | 39 | 12 | 27 | 0 |
| Development Fees | 37 | 27 | 10 | 1 |
| User Charges | 32 | 27 | 5 | 0 |
| Cluster Zoning | 28 | 21 | 7 | 3 |
| Slope/Density Zoning | 21 | 6 | 15 | 6 |
| Plan Conformance Rezoning | 19 | 1 | 18 | 14 |
| Mass "Up" or "Down" Zoning | 11 | 1 | 10 | 8 |
| Development Rights-Purchase or Transfer | 8 | 5 | 3 | 4 |
| Land Banking | 3 | - | 3 | 2 |
| Development Sequence Zoning | 4 | 4 | 0 | 4 |
| "Floating Zones" | 3 | 3 | 0 | 3 |
| **Group 3 Constraining Development** | | | | |
| Open Space Zoning | 26 | 5 | 21 | 8 |
| Open Space Easements | 23 | 5 | 18 | 4 |
| Zoning Moratorium | 18 | 8 | 10 | 5 |
| Sewer Connection Limits | 20 | 9 | 11 | 3 |
| Land Acquisition for Public Use | 20 | 12 | 8 | 1 |
| Prime Agricultural Land Preserves | 11 | 5 | 6 | 1 |
| Building Permit Moratorium | 11 | 0 | 11 | 0 |
| Watershed Protection Program | 13 | 8 | 5 | 1 |
| Transportation Access Limits | 12 | 7 | 5 | 2 |
| Water Connection Limits | 7 | 4 | 3 | 3 |
| Other Utility Connection Moratorium | 7 | 7 | 0 | 0 |

Source: Preliminary tabulations ABAG Local Policy Survey, 8/15/76. 65 cities reported of 76 responding. Special districts not included.

## HOW THE PLAN WAS PREPARED

A variety of agencies implement programs for controlling air pollution. Many other agencies directly or indirectly influence air quality through public decisions. Future air quality in the region will continue to be affected by Federal, State, regional and local actions regarding:

- The kinds of cars we drive
- The amount and type of industry in the region
- Infrastructure investment decisions for roads, sewers, and water
- The location of jobs and housing
- The level of public transportation available

With this as background, it is evident that an implementable plan has to involve those individuals, groups, and agencies directly affected by the plan. In particular, the plan has to involve those agencies primarily responsible for implementing and enforcing the plan's recommendations. A constraint is the program must be manageable to complete the work program tasks within a reasonable amount of time.

The plan was prepared by a Joint Technical Staff made up of staff from five agencies. The Association of Bay Area Governments (ABAG) assumed overall program management responsibilities. The Bay Area Air Quality Management District (BAAQMD) and Metropolitan Transportation Commission (MTC) provided direct support to ABAG under contract. The California Air Resources Board (CARB) and California Department of Transportation (Caltrans) provided in-kind staff support for the duration of the study.

Overall guidance to the Joint Technical Staff came from several groups:

- Interagency Management Committee - Upper level management representatives from ABAG, BAAQMD, and MTC met periodically to review the progress of the study and provide program guidance as needed.
- Air Quality Advisory Committee - An independent advisory committee with broad regional representation was established to critique and review the planning efforts. This body also provided the opportunity for any interested individuals or groups to comment on the development of the plan.
- Program Review Board - This group of Federal and State agency officials reviewed progress of regional water quality, water supply solid waste and air quality management plans. Overall program policy guidance was given as requested or needed.

In addition to the Joint Technical Staff, specialized air quality modeling assistance was provided in two ways:

- Consultant contracts with the Lawrence Livermore Laboratory (staff support) and the Lawrence Berkeley Laboratory (computer support)

- An air quality modeling committee was established to review and critique the air quality modeling work. This committee was composed of modeling experts from the California Air Resources Board, U.S. Environmental Protection Agency, Lawrence Livermore Laboratory, Bay Area Air Pollution Control District, Metropolitan Transportation Commission, california Department of Transportation, Systems Applications, Inc. (air quality modeling consultant), and Association of Bay Area Governments.

Overall, the plan represents the work of a number of agencies drawing upon many specialized disciplines. The staff and data resources used to prepare the plan have been considerable. Both the process and the results of the planning effort are documented in various technical memoranda, issue papers, and briefs. Because of budgetary constraints, more specialized reports and memoranda have not been widely produced and disseminated. Individuals interested in detailed aspects of different parts of the plan should contact ABAG for further information.

Section J and X of this chapter also describe intergovernmental consultation in plan development and implementation, as required by the 1977 Clean Air Act Amendments.

# Section-D

# AIR QUALITY PROBLEMS, CAUSES, AND FUTURE PROSPECTS

Any problem should be well defined before solutions are developed to solve it. Thus, prior to developing air quality control strategies, it is important to:

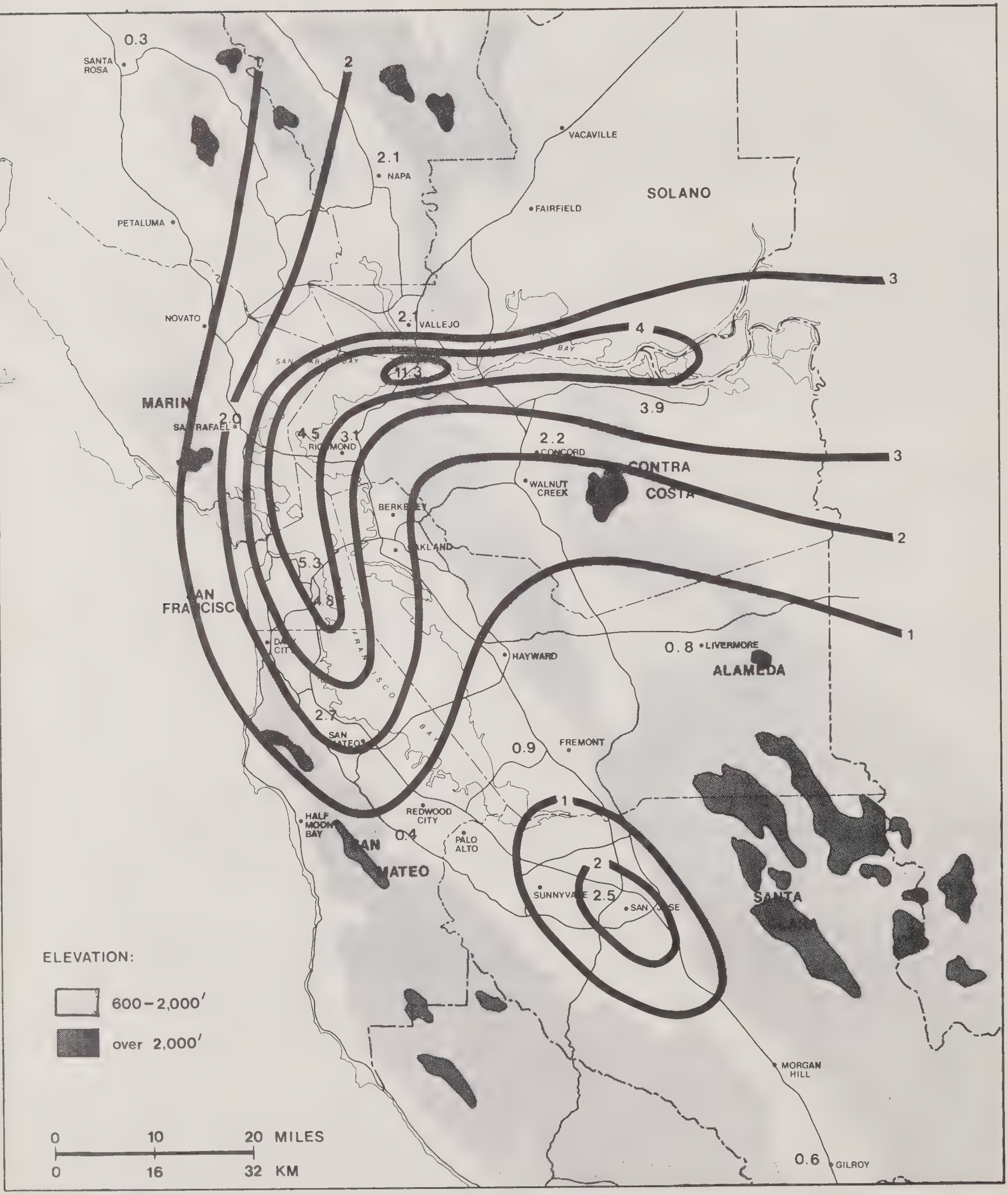
- Define the problem, or assess what past and present air quality levels have been with respect to air quality standards.
- Survey the causes, or inventory past and present emissions contributing to the problem.
- Assess future prospects, or project what future emissions and air quality are likely to be.

If future problems are projected, control strategies clearly need to be developed. This section summarizes what the magnitude and extent of future problems is likely to be and what the principal causes of the problem are.

## PAST AND PRESENT AIR QUALITY

The Bay Area Air Quality Management District maintains and operates an extensive air quality monitoring network throughout the region. Data are collected regularly for pollutants which have air quality standards established. These data are periodically summarized, and by reviewing annual reports it is relatively straightforward to define current problems.

The five pollutants of greatest interest to the region are sulfur dioxide ($SO_2$), total suspended particulate (TSP), carbon monoxide (CO), nitrogen dioxide ($NO_2$) and photochemical oxidants ($O_x$). Brief summaries of what past and present (1975-76) air quality levels were experienced in the Bay region follow.




**1975 Annual Average Sulfur Dioxide Values in parts per billion (ppb). Federal standard is 30 ppb.**

Figure 5

## Sulfur Dioxide

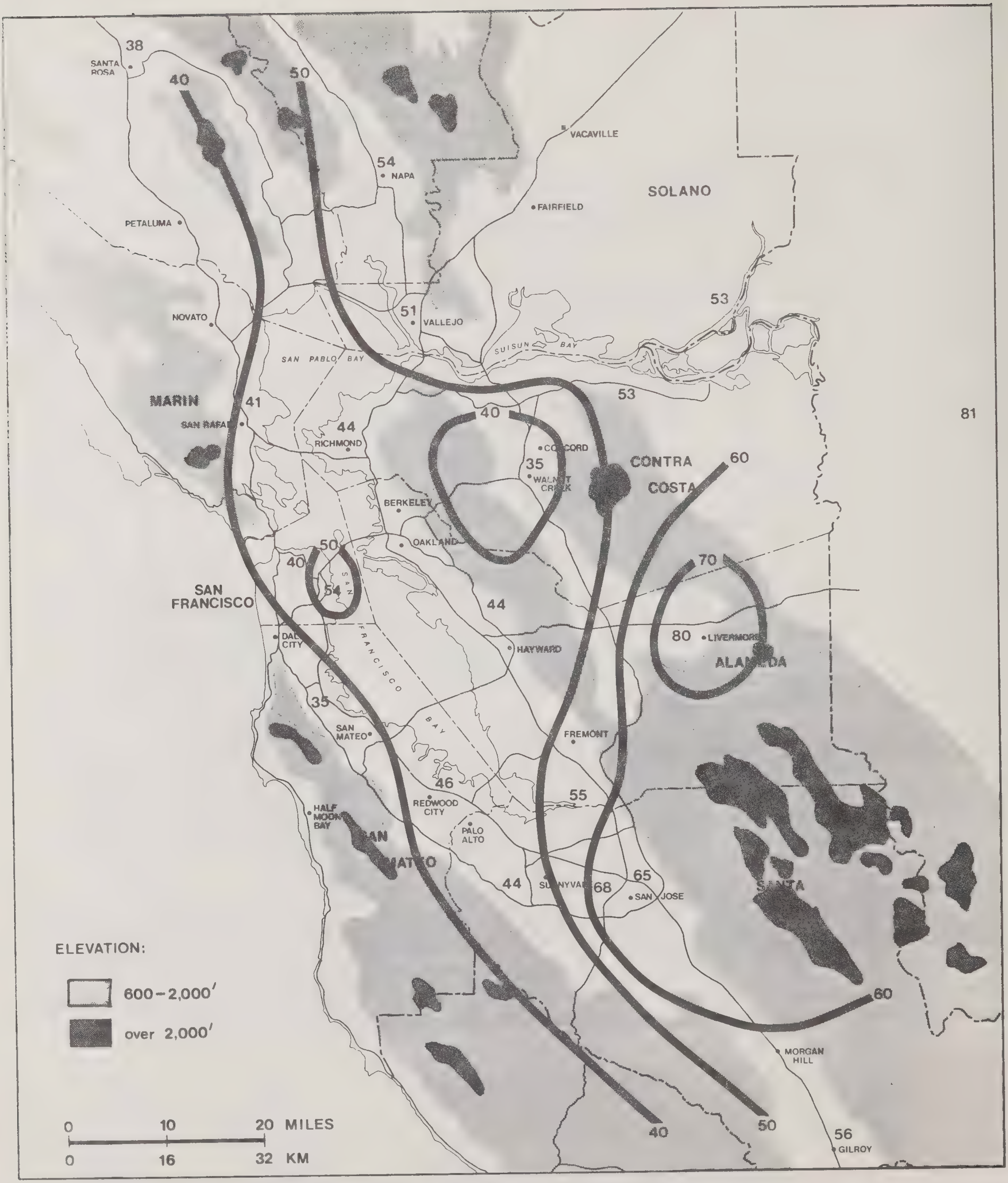
The map of annual average sulfur dioxide values for 1975 shows a relatively narrow band exceeding 3 parts per billion (ppb) centered on the shores of Contra Costa County with extensions to the San Francisco Airport and into the Delta. The Federal standard for sulfur dioxide ($SO_2$) annual average is 30 ppb, thus most of the Bay Area has less than one-tenth the $SO_2$ levels allowed by the Clean Air Act. The annual average for all District stations is 2.1 ppb, or 7% of the Federal standard.

The regional maximum of 11.3 ppb is recorded at Crockett, near a chemical plant which manufactures and ships $SO_2$ as its major product. Even here the annual levels are 60% below the Federal annual standard and encompass a small largely unpopulated area. The one 1975 excess of the State one-hour standard (.5 ppm, or 500 ppb) occurred at Crocket in July. However, there were numerous excesses of the District 3-minute regulation, which has a time frame 20 times more restrictive than the State standard and 60 times more restrictive than the Federal standard.

This annual average is a composite of varying seasonal patterns. In July and August, for example, the highest $SO_2$ values are at Pittsburg and the Delta, associated with summer air flow patterns. In December and January, drainage flow from the Central Valley along the Contra Costa shore carries the maximum $SO_2$ averages to San Francisco. A minor secondary maximum over San Jose occurs in September and October, apparently related to local food processing.

The $SO_2$ in the atmosphere is eventually considered converted to sulfate after extended residence and travel time, and a State sulfate standard of 25 $\mu g/m^3$ has been established. For 7 years the District has also monitored sulfate and has recorded only one excess of this standard. The pattern of highest sulfate corresponds very closely to that for $SO_2$, with mean values over 3 $\mu g/m^3$ in an arc along the Contra Costa shoreline.

The 1975 $SO_2$ average is 63% lower than that for 1969 when this monitoring program began. Despite the energy-related fuel-switch problems of 1973-74, the 3-year average for 1973-75 is 39% lower than that for 1969-71, due to stringent District control of major point sources. Projected decreases in global availability of clean fuels suggest increasing difficulty in maintaining the current low levels of sulfur gases.




**1975 Annual Geometric Means of Total Suspended Particulate in $\mu g/m^3$ (by hi-volume method with fiberglass filters). Federal primary standard is 75 $\mu g/m^3$. State standard is 60 $\mu g/m^3$.**

Figure 6

## Total Suspended Particulate

The annual geometric means (AGM) of total suspended particulate (TSP) show a pattern of low values near the coast increasing with distance inland, particularly into dry sheltered valleys. The values are given in micrograms per cubic meter ($\mu g/m^3$) which is a measure of weight. The Federal primary standard, expressed as an annual geometric mean is 75 $\mu g/m^3$ and the State standard is 60 $\mu g/m^3$. In 1975 the Santa Clara and Livermore Valley areas exceeded the State standard, and the Livermore Valley also exceeded the Federal standard.

The most respirable and visibility-reducing particles are very small, with diameters of 0.1 - 0.5 microns (or 0.0000039 - 0.0000197 inches), and their contribution to total weight is small in relationship to their significance. (One 5 micron particle affects the TSP value as much as 1000 of the 0.5 micron particles). Thus this standard is not an ideal guide to show that large silicate particles contribute heavily to the TSP values at our more inland stations such as Livermore. (A more detailed and extensive discussion characterizing TSP problems in the region is presented in Sections T and U).

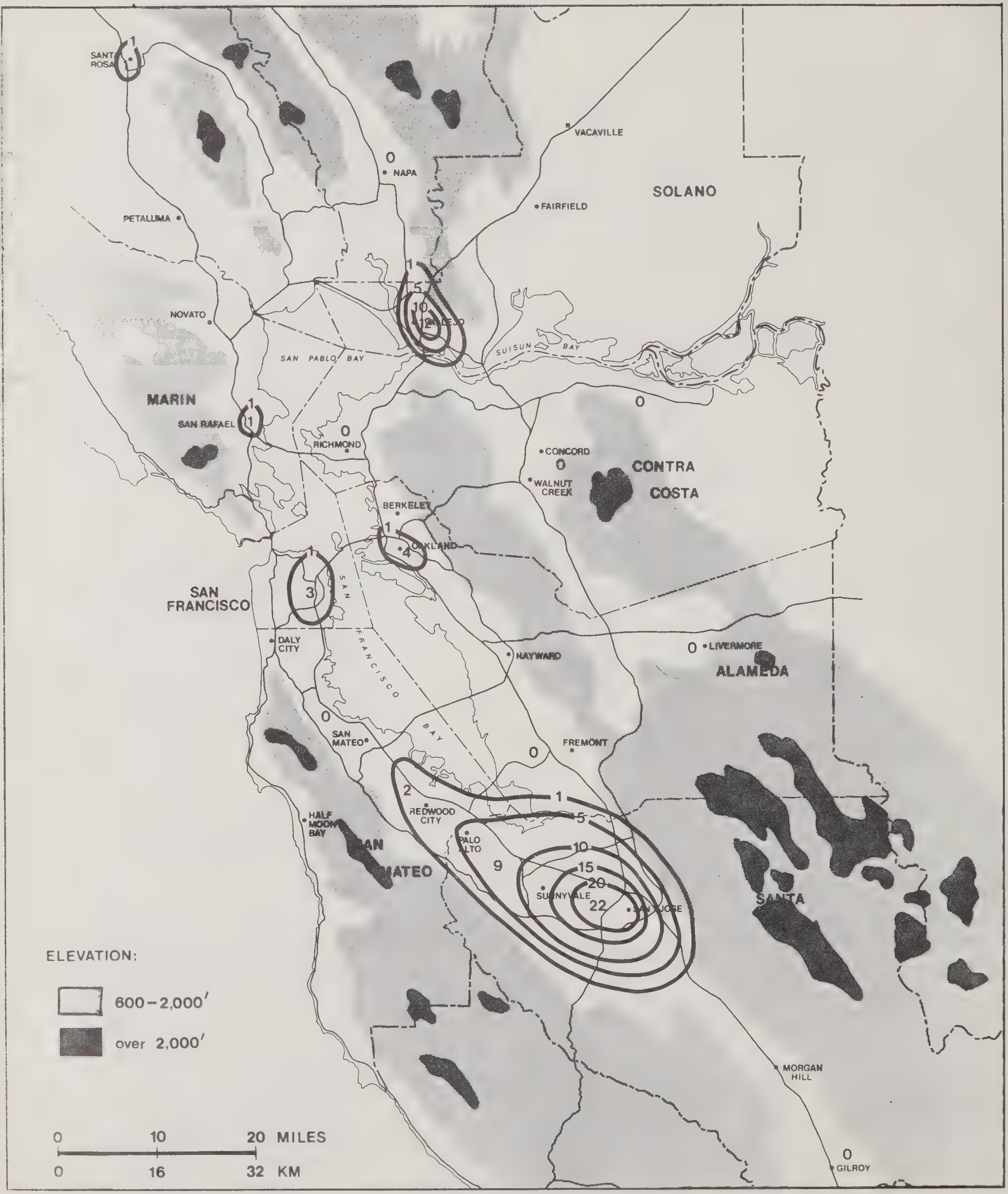
Another widely employed but less precise measure of particulate is the Coefficient of Haze (COH) method, for which no standards have been established, but which relates much better to visibility reduction. Here it is interesting to compare the 1975 COH and TSP annual geometric means for three District stations:

| | TSP, AGM | COH, AGM |
|---|---|---|
| Sunnyvale | 44 | 0.27 |
| Livermore | 80 | 0.27 |
| Richmond | 44 | 0.14 |

Sunnyvale has low TSP but high COH, indicating relatively numerous small, but few large particles; Livermore is high in both categories, and Richmond low in both categories. One may hopefully anticipate a Federal standard which better defines the real particulate problem.

One particulate species of particular concern has been lead. The District's annual average lead concentration has fallen from 1.30 $\mu g/m^3$ in 1970 to 0.70 $\mu g/m^3$ in 1975 or a decrease of 40%. The switch to non-leaded gasoline is primarily responsible for this improvement.

This decrease in lead values is not closely reflected in total particulate values, which have varied widely from year to year and station to station although an overall downward trend has been noted. Construction activities near a station tend to raise its TSP annual geometric mean for that year. Pittsburg, for example, had a TSP mean of 41 in 1972, 65 in 1973 and 50 in 1974, impacted by major construction in 1973.




**1975 Annual Number of Days with Carbon Monoxide Exceeding Federal Standard (9 parts per million for 8 hours).**

Figure 7

## Carbon Monoxide

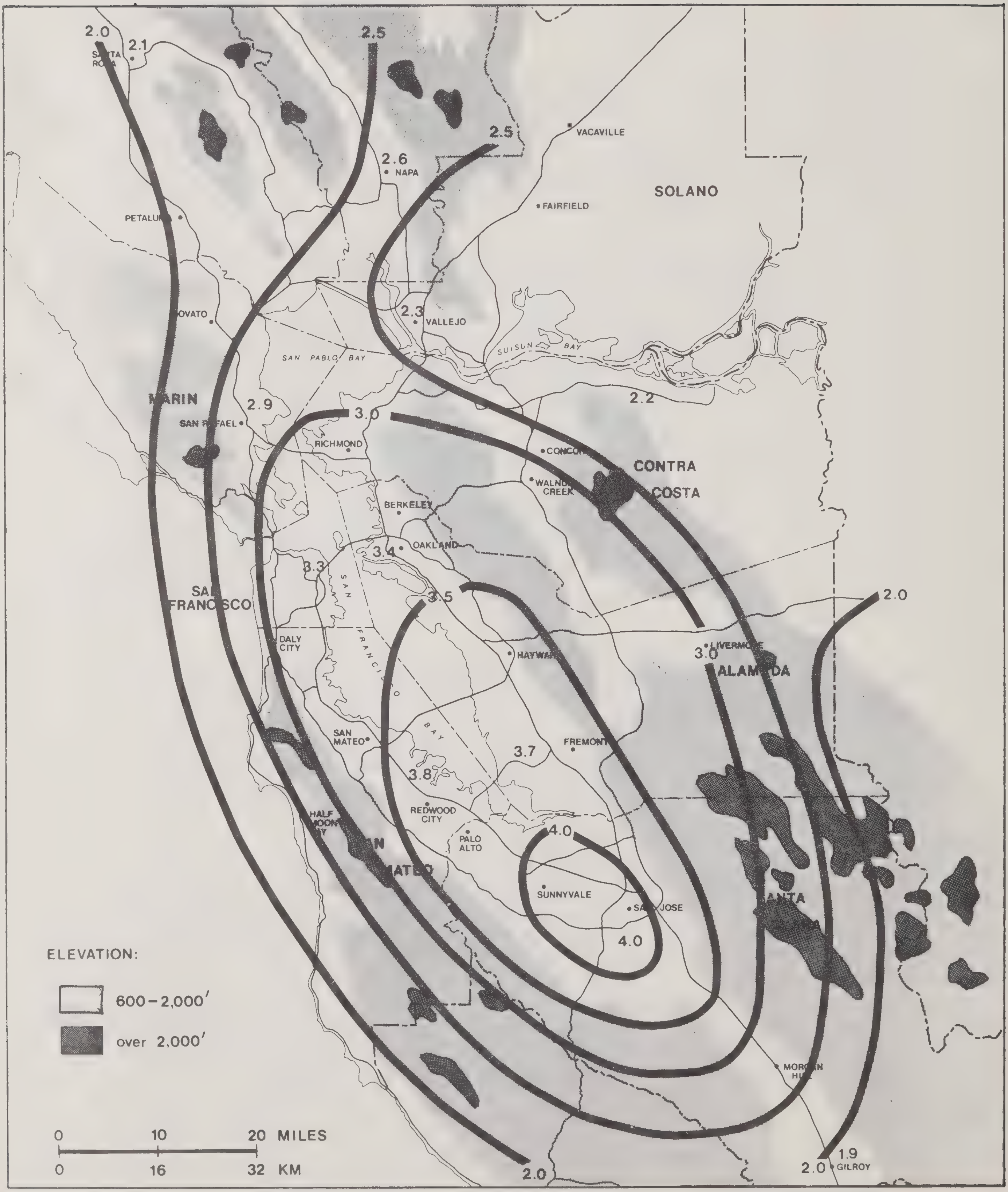
Maps of annual average values as drawn for the previous pollutants are of little value for carbon monoxide (CO) since over 90% of the CO is emitted from vehicular sources resulting in a complex latticed pattern corresponding closely to highway networks. These tail-pipe level emissions are also particularly sensitive to low-level radiation inversions, resulting in very strong daily and seasonal cyclic variations.

According to data collected by the Bay Area Air Quality Management District at its continuous urban monitoring stations, the Federal one-hour CO standard has not been exceeded in the current decade, while the Federal eight-hour average standard of 9 ppm has been frequently exceeded in some areas. Because of the very localized nature of CO concentrations, it is likely that the one-hour standard has been exceeded in other locations. For example, a recent BAAQMD monitoring program conducted at San Francisco International Airport recorded one-hour average CO levels as high as 86 ppm. Figure 1 illustrates the number of days in 1975 which were detected by the monitoring network to exceed the eight-hour standard. The major excess area is the Santa Clara Valley, centered on San Jose and extending to Sunnyvale. There is a small secondary maximum over Vallejo, and isolated urban-center cases at San Francisco, Oakland and San Rafael. Table 2 summarizes the excesses of the CO standards which have been recorded in recent years. The highest eight-hour average CO level recorded in recent years was 20.2 ppm, which occurred in San Jose on November 5-6, 1976.

Over 80 percent of the violations occur in November, December, and January. On a daily basis more than 90 percent of these eight-hour excesses occur between 4 p.m. and 2 a.m. The timing of the eight-hour excesses can be explained by the winter season formation of surface-based radiation inversions which correspond in time period to the evening traffic maximum. Once initiated, a sustained buildup of high CO levels occurs and remains undispersed for many hours.

The Santa Clara Valley on a "meso-scale" and the Vallejo station on a "micro-scale" show a strong "drainage pool" effect. That is, the light surface winds under the radiation inversion drain downslope (as water would) and collect pools of contaminants. The Vallejo station appears to be in such a micro-scale pool impacted by Interstate 80.

The District average CO data have shown an 11% decrease from 1970 to 1975. Measured ambient CO levels have decreased less rapidly than total emission, apparently because the ambient values in this air basin are most sensitive to winter evening driving modes and patterns.




**1975 Annual Average Nitrogen Dioxide Values in parts per hundred million (pphm). Federal standard is 5.0 pphm.**

Figure 8

## Nitrogen Dioxide

The map of annual average nitrogen dioxide values has the most straightforward pattern of any contaminant, showing a large maximum centered over the Santa Clara Valley. The only Federal $NO_2$ standard is for the annual average with a limit of 5.0 pphm. The District has never exceeded this Federal $NO_2$ standard, but San Jose and Sunnyvale are within 80% of it, while Santa Rosa and Gilroy at the lower bounds are near 40% of it.

Nitrogen dioxide is most important as a factor in the photochemical smog formation cycle, but is also a major factor in the dirty brown discoloration of the air. A State one-hour standard of 25 pphm has also been established (near the discoloration level). In 1975 this State standard was exceeded only once, at the Fremont station.

Since the full activation of the District's $NO_2$ monitoring program in 1968, the District-wide annual average has decreased 11%, but here an examination of individual stations is more elucidating. San Francisco has fallen from 4.0 to 3.3 pphm for a decrease of 18%, but San Jose has risen 3.8 to 4.0 pphm, for an increase of 5%.

The $NO_2$ develops in the atmosphere from nitric oxide (NO), a primary emission from motor vehicles. An examination of the NO changes helps to explain the $NO_2$ changes. From 1968 to 1975 the annual NO averages at San Francisco have decreased 49%, while those at San Jose have increased 20%. The Santa Clara Valley now appears to be the principal source area for this contaminant, rather than a receptor area as was more nearly true a decade ago. Independent data of total vehicle-miles by county tend to confirm the current primacy of Santa Clara County.

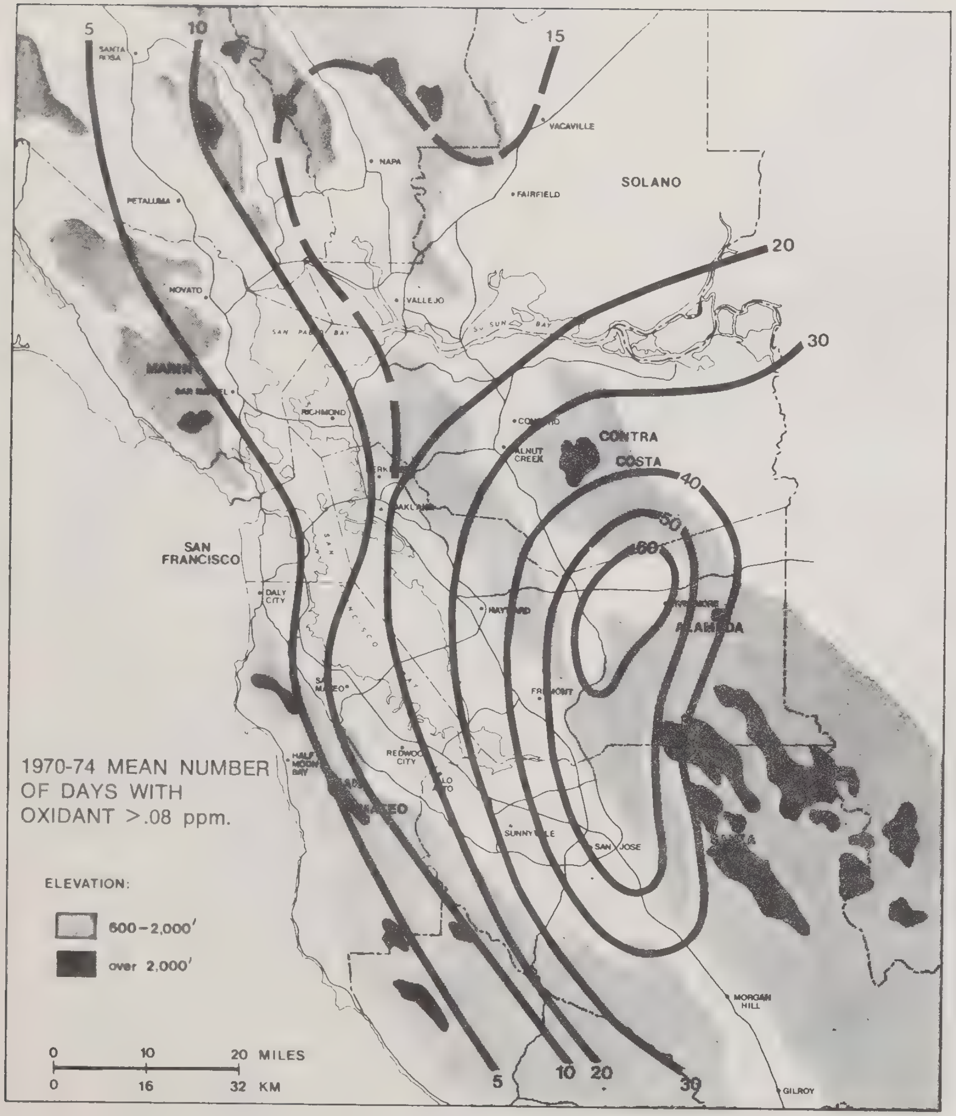



Figure 9a

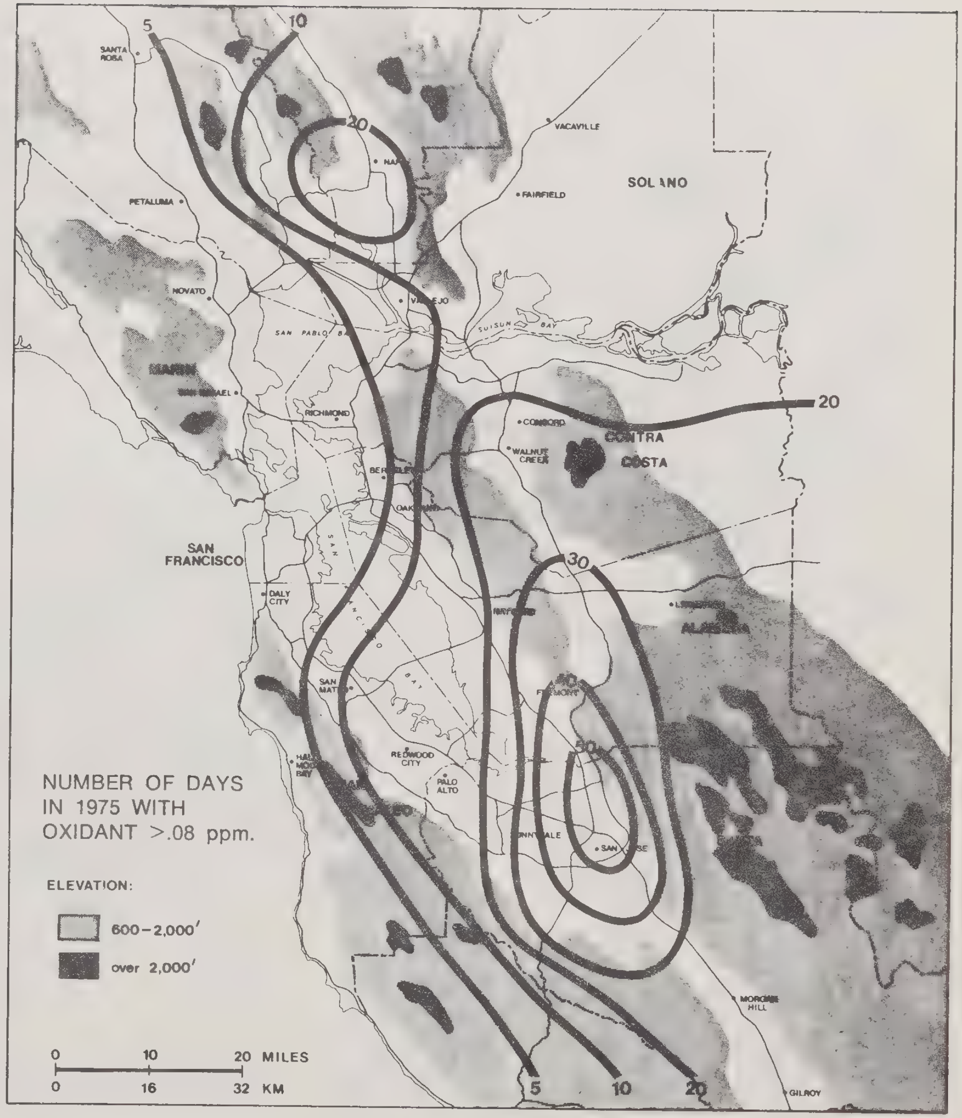



Figure 9b

## Photochemical Oxidants

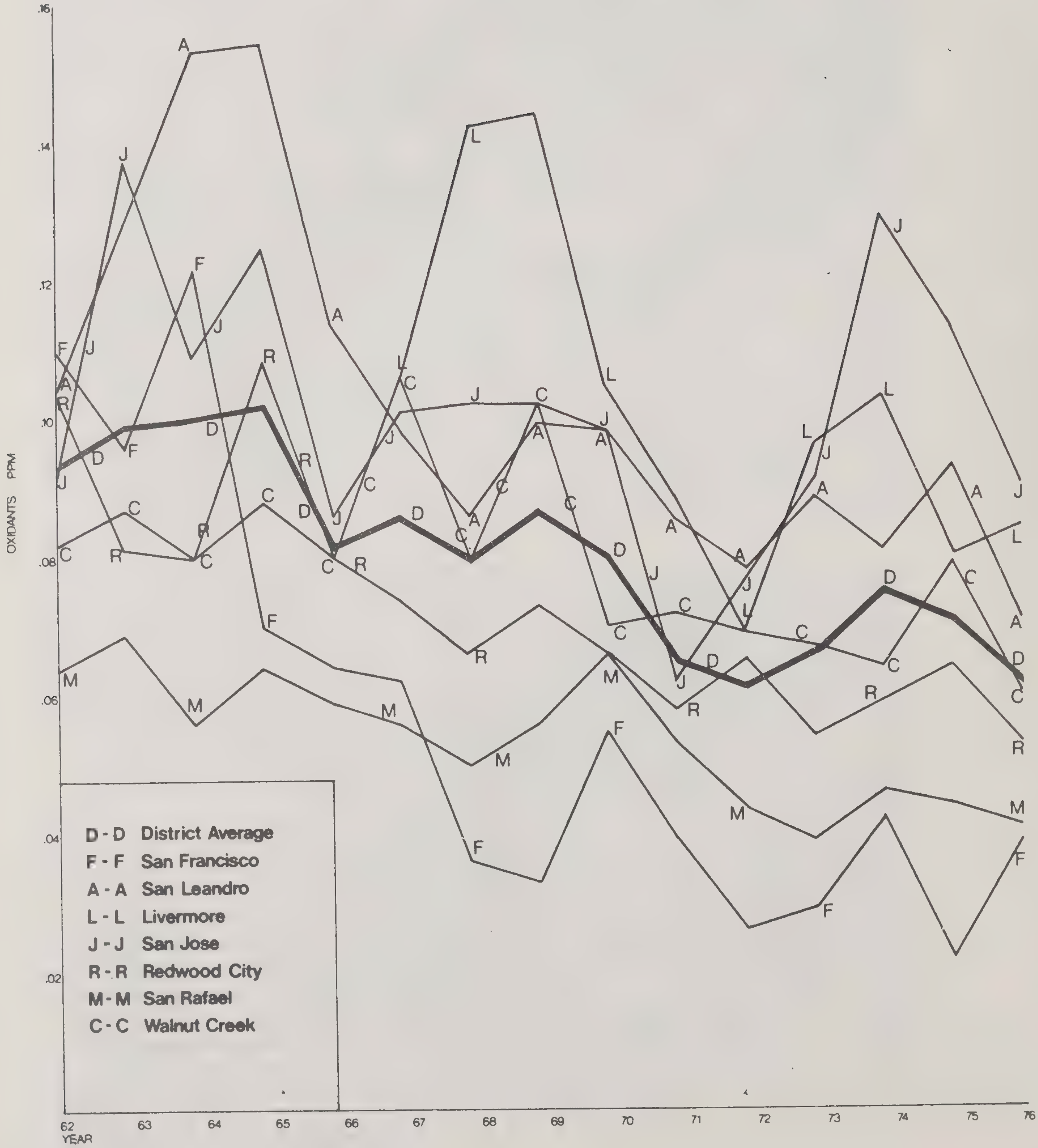
Photochemical oxidant, as the contaminant of initial and deepest concern in California has now been continuously monitored for 15 years by the BAAPCD. After peaking in 1965, the oxidant levels have shown a clear downward trend for the past 11 years, despite large annual weather-induced fluctuations. Days exceeding the Federal one-hour standard of .08 ppm averaged 131 in the 1965-69 five year period (pentad) and 85 in the 1970-74 pentad. For the 1975 base year there were 69 days over standard, and preliminary totals for 1976 show 65 days. Despite more than 50% improvement over the past decade, oxidant remains the largest and least tractable problem in terms of air quality maintenance.

For oxidant the accompanying maps plot the number of days over standard in 1975, and for comparison the average values in the 1970-74 pentad. Both maps show minimum excesses (0 to 5 days) along the coast, but in 1975 the clean band had widened and extended further inland. Maximums in both cases are over the inland sheltered valleys, but there are two significant differences. First, the 1975 intensity of the maximum is 20% lower, decreasing from 60 days to 50 days. (Preliminary 1976 data indicates a further weakening of this maximum to less than 35 days). Second, the center of the maximum has shifted from the Livermore Valley to the East Santa Clara Valley. (Preliminary 1976 data show the center remaining as in 1975, but extending more toward Gilroy then toward Livermore.)

Since the formation of oxidant is highly weather-dependent, the District has developed a "trend study" technique to damp out the primary weather factors (temperature and inversion height) and compare the oxidant levels only for days when these conditions favor its formation. Results of this study (updated to include 1976) are shown in the final graph. On oxidant-conducive days, the District average (for our 7 long-term stations) peaked at .10 ppm in 1965 and has fallen to .06 ppm in 1976. In 1971 this average fell below the Federal standard and has remained below it every since. The two long-term stations with averages remaining over standard are San Jose and Livermore.

The southeastward migration of highest values over the years is another noteworthy feature of the oxidant trend graph. San Leandro led (with over .15 ppm) in 1964 and 1965; Livermore led (with over .14 ppm) in 1968 and 1969; San Jose led (with .11 to .13 ppm) in 1974 and 1975. These highest station averages have fortunately decreased at nearly the same rate as the overall District average. The reasons for the shift appear quite complex--related to the 15-year shifts in population and vehicle use, and to the changes in emission mix and emission patterns. Additionally, the increases in emissions of primary contaminants have been into the sheltered valleys topographically and meteorologically least favorable for mixing and dispersion.

Figure 10




Trend of Average High-Hour Oxidant Concentrations For Days With Comparable Temperature & Inversion Conditions (April through October Photochemical Oxidant Seasons 1962-1976

## Air Quality Summary

The previous figures have shown graphically how air pollution is distributed throughout the region. Table 6 presents in tabular form by individual monitoring station what air quality was like in 1976. Violations of Federal or State standards are shown, as well as maximum concentration levels experienced for the year.

Table 6. **AIR POLLUTION IN THE BAY AREA BY STATION AND CONTAMINANT: 1976**

For oxidant and for nitrogen dioxide, "max" is the highest hourly average value expressed in parts per hundred million. For carbon monoxide, "max" is highest 8-hour average value in parts per million. (The one-hour standard for CO was never exceeded during the year.) For sulfur dioxide, "max" is highest 24-hour average value expressed in parts per million. For total suspended particulates (TSP), "mean" is annual geometric mean in micrograms per cubic meter.

| | OXIDANT | | | CO | | $NO_2$ | | $SO_2$ | | TSP | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stations | Max | * | M** | Max. | * | Max. | * | Max. | + | Mean | + |
| San Francisco | 13 | 2 | 3 | 11.0 | 4 | 25 | 1 | .053 | 1.8 | 55 | 9.3 |
| San Rafael | 12 | 5 | 8 | 15.5 | 7 | 13 | 0 | .015 | 0.0 | 36 | 6.4 |
| Richmond | 13 | 7 | 9 | 6.8 | 0 | 23 | 0 | .013 | 0.0 | 48 | 12.0 |
| Pittsburg | 15 | 29 | 22 | 5.5 | 0 | 19 | 0 | .015 | 0.0 | 61 | 16.0 |
| Concord | 17 | 24 | — | 7.4 | 0 | 23 | 0 | .030 | 0.0 | 51 | 12.8 |
| Walnut Creek | 14 | 10 | 28 | — | — | — | — | — | — | — | — |
| Oakland | 15 | 6 | 7 | 10.5 | 7 | — | — | — | — | — | — |
| San Leandro | 16 | 9 | 23 | — | — | — | — | — | — | — | — |
| Hayward | 18 | 30 | — | — | — | — | — | — | — | — | — |
| Fremont | 16 | 21 | 39 | 9.8 | 1 | 28 | 2 | .011 | 0.0 | 62 | 18.1 |
| Livermore | 17 | 29 | 60 | 7.1 | 0 | 18 | 0 | .005 | 0.0 | 85 | 41.3 |
| Alum Rock | 16 | 31 | — | — | — | — | — | — | — | — | — |
| San Jose | 17 | 32 | 40 | 20.2 | 61 | 28 | 3 | .015 | 0.0 | 71 | 20.8 |
| Gilroy | 21 | 30 | — | 6.8 | 0 | 23 | 0 | .011 | 0.0 | 62 | 11.7 |
| Los Gatos | 14 | 19 | 32 | — | — | — | — | — | — | — | — |
| Sunnyvale | 15 | 22 | — | 12.8 | 14 | 30 | 4 | .008 | 0.0 | 50 | 8.6 |
| Mountain View | 14 | 11 | 12 | — | — | — | — | — | — | — | — |
| Redwood City | 17 | 16 | 15 | 10.2 | 10 | 21 | 0 | .007 | 0.0 | 59 | 13.0 |
| Burlingame | 15 | 3 | 10 | 9.5 | 1 | 22 | 0 | .018 | 0.0 | 49 | 7.0 |
| Petaluma | 9 | 5 | 6 | — | — | — | — | — | — | — | — |
| Santa Rosa | 9 | 1 | — | 9.5 | 1 | 15 | 0 | .004 | 0.0 | 66 | 8.6 |
| Sonoma | 13 | 21 | — | — | — | — | — | — | — | — | — |
| Napa | 12 | 16 | 16 | 10.8 | 2 | 11 | 0 | .009 | 0.0 | 65 | 11.8 |
| Vallejo | 18 | 21 | 16 | 18.0 | 40 | 14 | 0 | .014 | 0.0 | 52 | 10.2 |
| Fairfield | 14 | 17 | 16 | — | — | — | — | — | — | — | — |
| Crockett | — | — | — | — | — | — | — | .026 | 0.0 | — | — |
| Martinez | — | — | — | — | — | — | — | .020 | 0.0 | — | — |

*Number of days ambient air quality standard was exceeded. (Federal oxidant standard >8 pphm.)
M** For comparison, average number of days oxidant standard was exceeded in 1970-1974 mean.
+Percent of observed days when State air quality standard was exceeded.

Source: Bay Area Air Pollution Control District, 1977

## PRESENT AND PROJECTED EMISSIONS

This section presents a summary of present and projected emissions of five major air contaminants for the San Francisco Bay Region. The purpose of the emissions inventory is to identify each significant source of pollutants contributing to the air quality problems of the region. In some cases, it is possible to identify a single category of sources as being the major contributor to a given problem (e.g., carbon monoxide from motor vehicles or sulfur dioxide from fuel combustion in industrial and utility boilers). In other cases such as for photochemical oxidant, no single category of sources can be identified as the root of the problem. By identifying the most significant sources in each case, the emissions inventory provides direction for efforts to control emissions and minimize the problems they cause. Thus, the inventory is a crucial prerequisite to the development of any plan to improve air quality.

To develop a long range plan to improve air quality, it is necessary to know not only what current emission levels are, but what future emission levels will be. As described in the AQMP/Tech Memo 2 (December 1976), estimates of current emissions from each category of sources are combined with estimates of the rate of growth in each case and the expected effects of control programs which are in effect now, or adopted and scheduled for implementation. The one exception to this is the Bay Area Air Quality Management District's New Source Review rule, which is not included in the emission projections. This is necessary so that the effectiveness of New Source Review as well as alternative New Source Review rules can be evaluated equally with other control programs. The projected emissions thus reflect historical growth trends.

### Summary of the Emissions Inventory

Emission inventories have been compiled for 1975, 1985, and the year 2000, and are summarized in Tables 7, 8 and 9. They are also shown in graphic form in Figures 11 and 15. Estimates of stationary sources and aircraft emissions were made by the Bay Area Air Quality Management District while motor vehicle emissions estimates were made through the joint efforts of the Association of Bay Area Governments, Metropolitan Transportation Commission and California Air Resources Board.

For hydrocarbons, the most significant source categories are organic compounds evaporation (otherwise known as organic solvents or volatile organic compounds) and both light and heavy duty vehicles. Each of these source categories has previously been the target of control efforts. Further controls will be necessary if significant air quality improvement is to be made. Total hydrocarbon emissions were projected to decline somewhat by 1985 due to controls on the books (prior to adoption in June of the AQMP), but to rise again by the year 2000 to the 1975 levels, making it apparent that more controls are necessary. Such controls were identified in the process of developing the AQMP, and adopted by the General Assembly.

For oxides of nitrogen, the principal source categories are stationary source fuel combustion and motor vehicles. Efforts to control motor vehicle $NO_x$ emissions have been controversial in recent years, while stationary source $NO_x$ control has been limited to only the largest sources.

The dilemma of pursuing $NO_x$ control is that $NO_x$ alone is not a problem in the Bay Area. It is a contributor to the photochemical oxidant problem, but its precise role has not been well defined to date. $NO_x$ emissions are projected to remain at a relatively constant level over the next 20-25 years.

By 1985, the expected increase in stationary source $NO_x$ emissions due to increased use of fuel oil will be offset by additional motor vehicle $NO_x$ control. By the year 2000, increased use of nuclear fuels for electric power and increased siting of electric power generating facilities outside of the Bay Area have been assumed to offset increased $NO_x$ emissions in other source categories.

In the case of carbon monoxide, light and heavy duty motor vehicles are by far the most significant sources. Unlike hydrocarbon and $NO_x$ emissions, CO emissions are projected to be substantially greater in the year 2000 than they are in 1975. The principal causes are the overall growth in vehicle activity over the 25 year period, and the expected deterioration of current vehicle emission control devices.

Sulfur dioxide emissions are due primarily to stationary source fuel combustion, and petroleum refining and chemical operations. A substantial increase in $SO_2$ emissions is projected to occur by 1985, due primarily to the progressively limited supplies of natural gas and the expected switch to fuel oil and coal for combustion processes. $SO_2$ emissions decrease slightly by the year 2000 due to an assumed switch of a portion of PG&E's electric power generating capacity to nuclear plants.

Finally, emissions of suspended particulate matter are produced from many diverse sources, with no single source or sources contributing a large share. Emissions for this pollutant are projected to increase steadily between 1975 and 2000. A significant unknown is the contributions to particulates from windblown dust and secondary organics (photochemical aerosol). Until these unknowns are better defined, it will be difficult to properly interpret the emission inventory for particulates.

Figures 16-18 provide a more detailed breakdown of certain large emission categories. Figure 16 divides motor vehicle emissions into the major vehicle categoreies. Figures 17 and 18 detail the organic solvent and combustion emissions by source type for 1985.

TABLE 7. 1975 EMISSIONS BY MAJOR SOURCE CATEGORY*

| | EMISSIONS (TONS/DAY) | | | | |
|---|---|---|---|---|---|
| MAJOR SOURCE CATEGORY | HC | $NO_x$ | CO | $SO_2$ | Part. |
| Petroleum Refining | 25.2 | 5.9 | - | 39.0 | 2.5 |
| Chemical | 5.5 | 3.1 | 37.3 | 84.6 | 4.9 |
| Other Industrial/Commercial | 10.2 | 2.5 | 21.7 | 5.9 | 75.3 |
| Petroleum Refinery Evaporation | 46.0 | - | - | - | - |
| Gasoline Distribution | 60.4 | - | - | - | - |
| Other Organic Compounds Evaporation (Organic Solvents) | 311.1 | - | - | - | - |
| Combustion of Fuels | 8.1 | 196.0 | 17.5 | 43.7 | 16.3 |
| Burning of Materials | 19.8 | 1.4 | 58.2 | 0.3 | 12.9 |
| Off-Highway Mobile Sources | 45.0 | 59.4 | 277.7 | 25.8 | 5.2 |
| Aircraft | 19.6 | 13.5 | 54.5 | 1.3 | 9.0 |
| Light-duty Automobiles | 340.1 | 231.7 | 3,672.0 | 7.4 | 27.8 |
| Other Motor Vehicles | 132.2 | 167.8 | 1,814.0 | 11.3 | 15.2 |
| TOTAL (TONS/DAY) | 1,023 | 731 | 5,953 | 219 | 169 |

* Assumes controls existing and projected before implementation of this plan.

TABLE 8. 1985 EMISSIONS BY MAJOR SOURCE CATEGORY*

| MAJOR SOURCE CATEGORY | HC | $NO_x$ | CO | $SO_2$ | Part. |
|---|---|---|---|---|---|
| | EMISSIONS (TONS/DAY) | | | | |
| Petroleum Refining | 41.0 | 15.2 | - | 67.5 | 4.4 |
| Chemical | 5.6 | 2.9 | 37.5 | 89.1 | 5.2 |
| Other Industrial/Commercial | 11.1 | 2.7 | 24.0 | 6.5 | 80.8 |
| Petroleum Refinery Evaporation | 50.0 | - | - | - | - |
| Gasoline Distribution | 27.1 | - | - | - | - |
| Other Organic Compounds Evaporation (Organic Solvents) | 344.8 | - | - | - | - |
| Combustion of Fuels | 11.5 | 321.1 | 21.3 | 213.9 | 34.5 |
| Burning of Materials | 22.2 | 1.5 | 62.7 | 0.3 | 13.9 |
| Off-Highway Mobile Sources | 50.3 | 73.7 | 322.6 | 30.9 | 6.3 |
| Aircraft | 20.2 | 19.6 | 69.9 | 1.6 | 11.4 |
| Light-duty Automobiles | 117 | 89.3 | 1,460.0 | 9.7 | 18.8 |
| Other Motor Vehicles | 96 | 165.8 | 1,369.0 | 15.0 | 16.3 |
| TOTAL (TONS/DAY) | 797 | 692 | 3,367 | 435 | 192 |

* Assumes controls existing and projected before implementation of this plan.

TABLE 9. 2000 EMISSIONS BY MAJOR SOURCE CATEGORY*

| MAJOR SOURCE CATEGORY | EMISSIONS (TONS/DAY) HC | $NO_x$ | CO | $SO_2$ | Part. |
|---|---|---|---|---|---|
| Petroleum Refining | 55.4 | 20.0 | - | 88.9 | 5.8 |
| Chemical | 6. | 3.9 | 37.5 | 119.8 | 6.1 |
| Other Industrial/Commercial | 12.7 | 3.1 | 24.0 | 7.4 | 90.5 |
| Petroleum Refinery Evaporation | 52.1 | - | - | - | - |
| Gasoline Distribution | 28.2 | - | - | - | - |
| Other Organic Compounds Evaporation (Organic Solvents) | 493.4 | - | - | - | - |
| Combustion of Fuels | 15.0 | 279.8 | 25.7 | 129.9 | 30.7 |
| Burning of Materials | 23.6 | 1.7 | 69.7 | 0.4 | 22.5 |
| Off-Highway Mobile Sources | 75.4 | 94.1 | 389.3 | 31.1 | 7.8 |
| Aircraft | 27.8 | 32.7 | 106.3 | 2.5 | 19.4 |
| Light-duty Automobiles | 160.6 | 77.1 | 1,497.0 | 13.2 | 22.3 |
| Other Motor Vehicles | 107.1 | 208.4 | 1,091.0 | 20.4 | 19.8 |
| TOTAL (TONS/DAY) | 1,058 | 721 | 3,241 | 414 | 225 |

* Assumes controls existing and projected before implementation of this plan.

Figure-11

# HYDROCARBON EMISSION TRENDS

SAN FRANCISCO BAY REGION

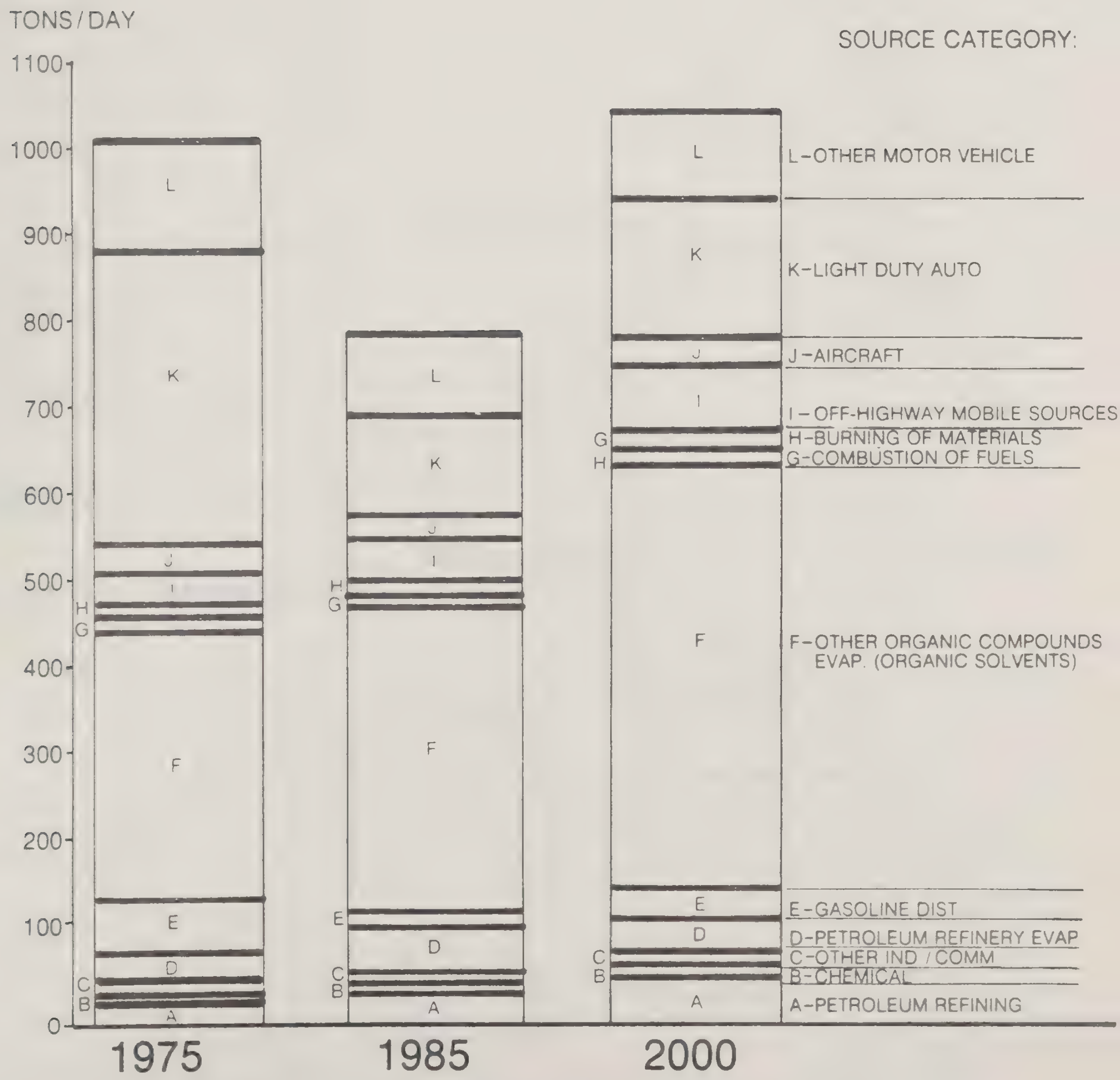


Figure-12

## NITROGEN OXIDES EMISSION TRENDS

SAN FRANCISCO BAY REGION

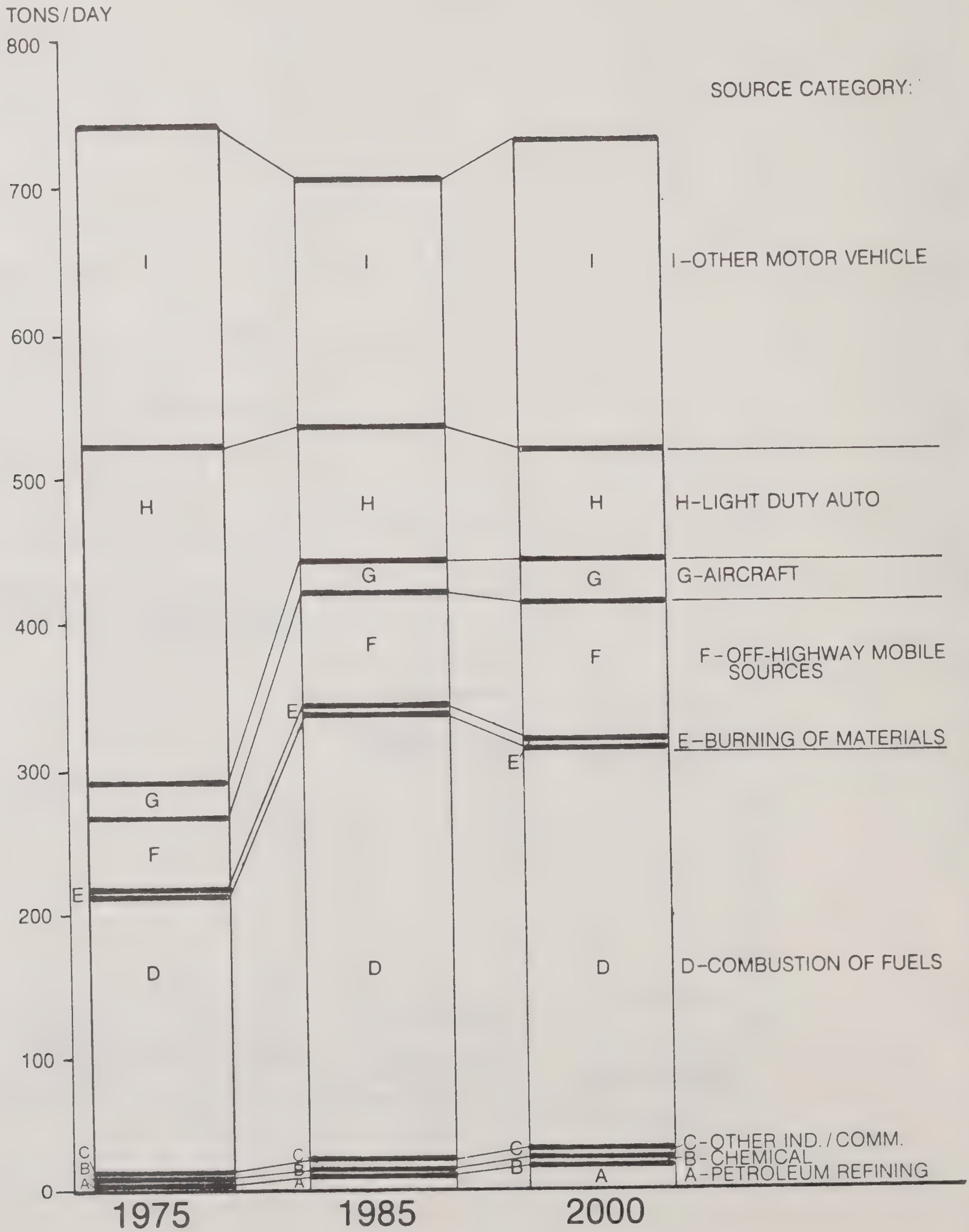


Figure-13

# CARBON MONOXIDE (CO) EMISSION TRENDS

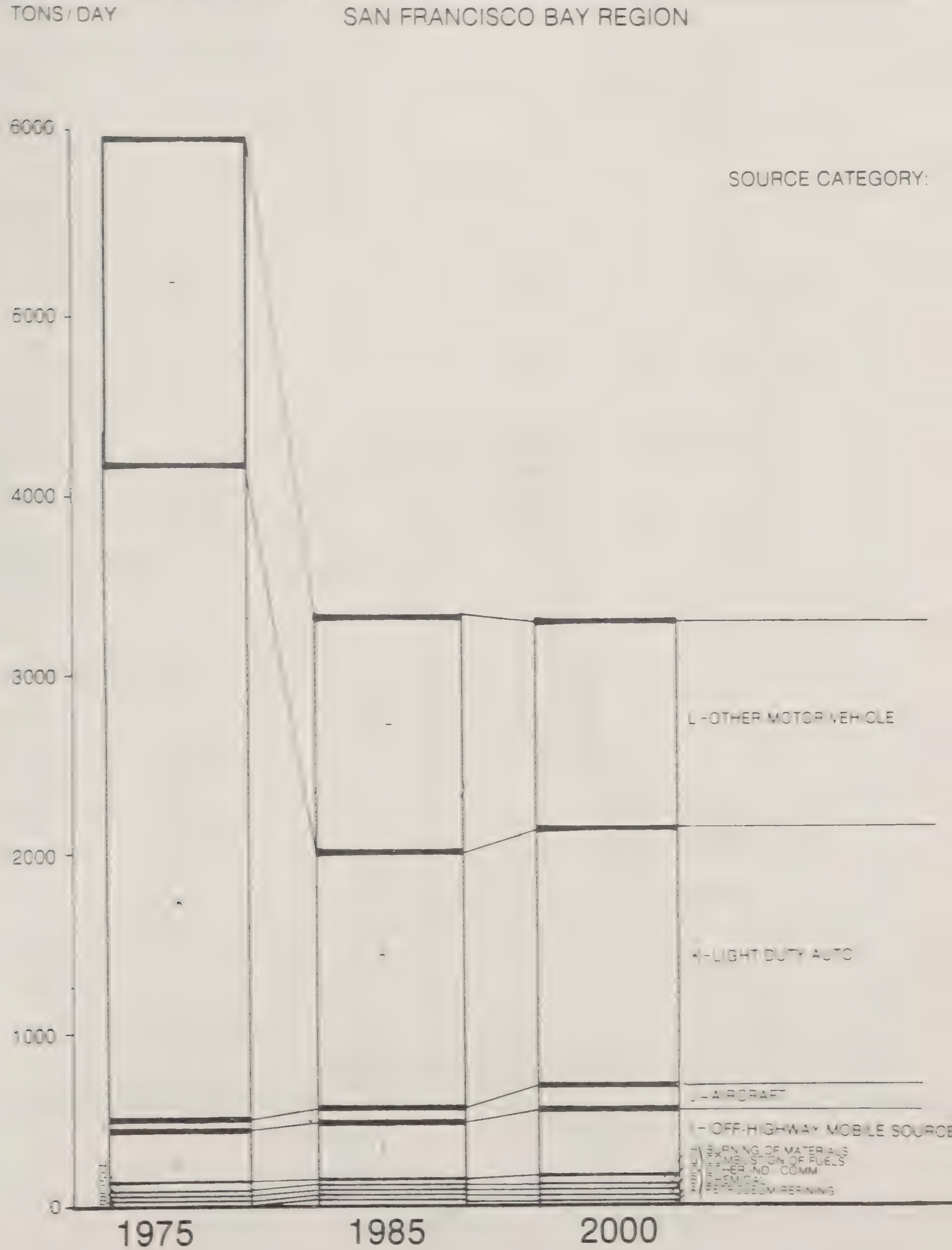


Figure – 14

## SULFUR DIOXIDE EMISSION TRENDS

SAN FRANCISCO BAY REGION

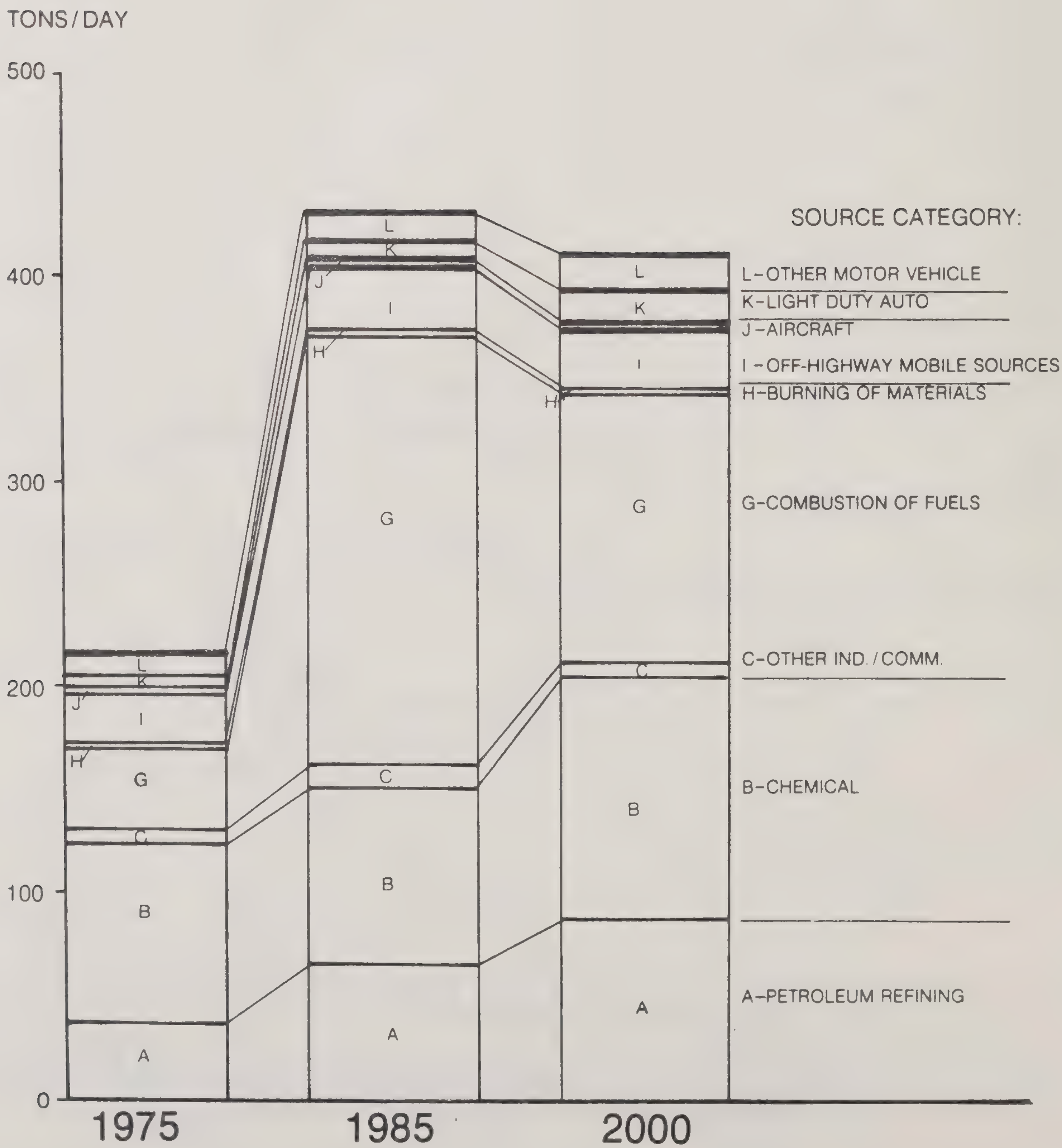


Figure – 15

# PARTICULATES EMISSION TRENDS

SAN FRANCISCO BAY REGION

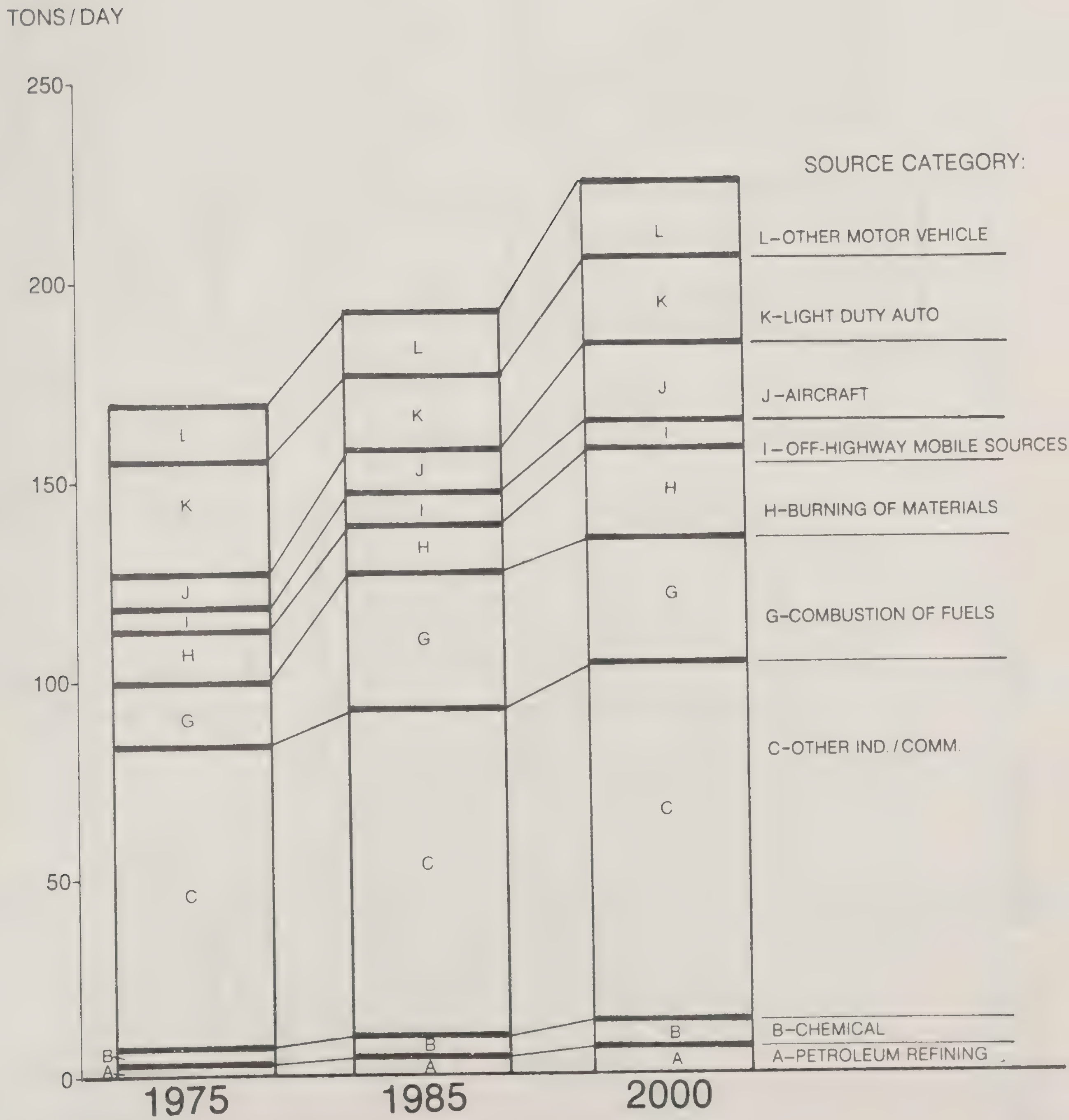


Figure 16

## MOTOR VEHICLE EMISSIONS (1985)

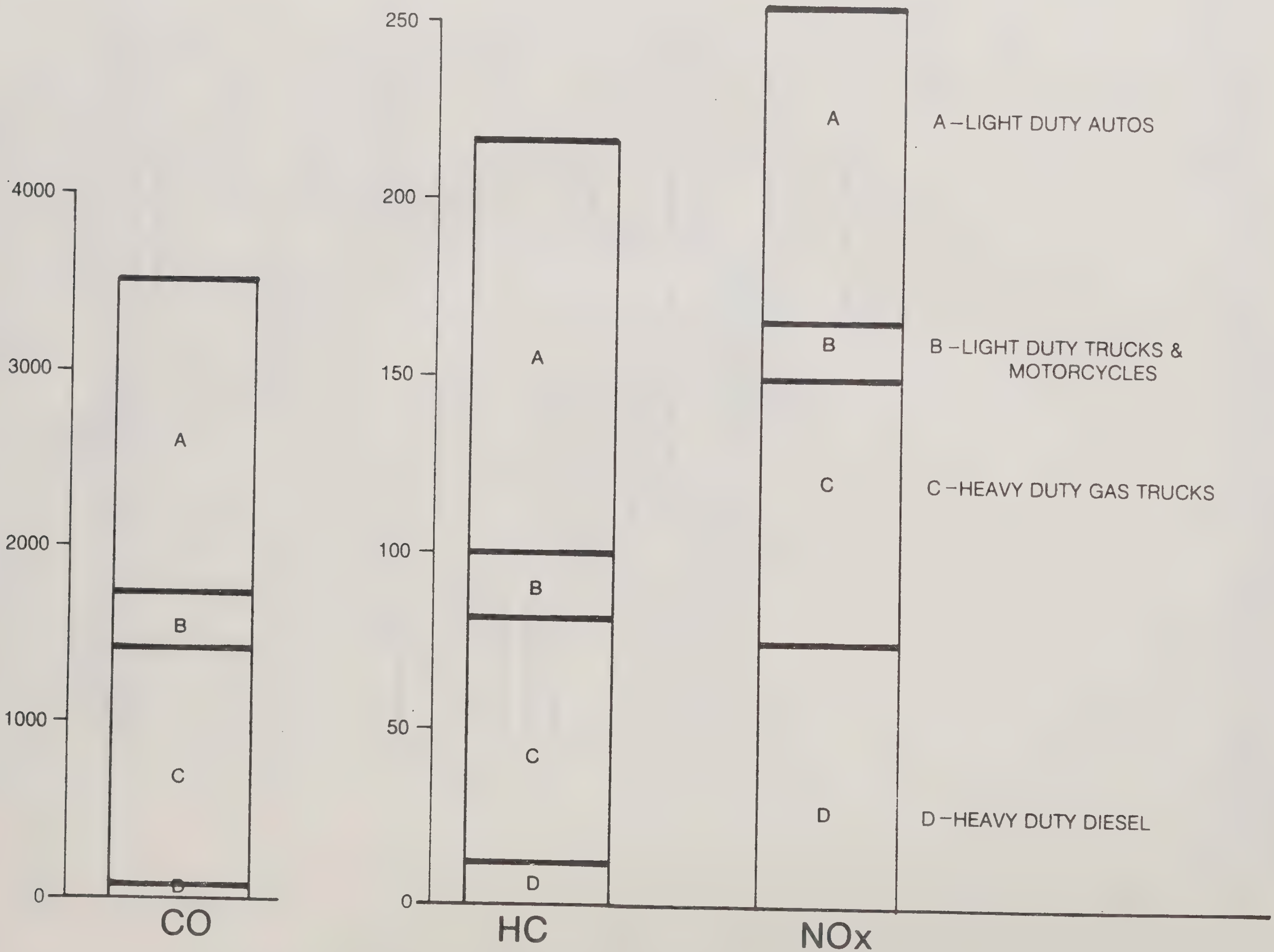


Figure-17

# BREAKDOWN OF ORGANIC SOLVENT EMISSIONS BY SOURCE TYPE IN 1985

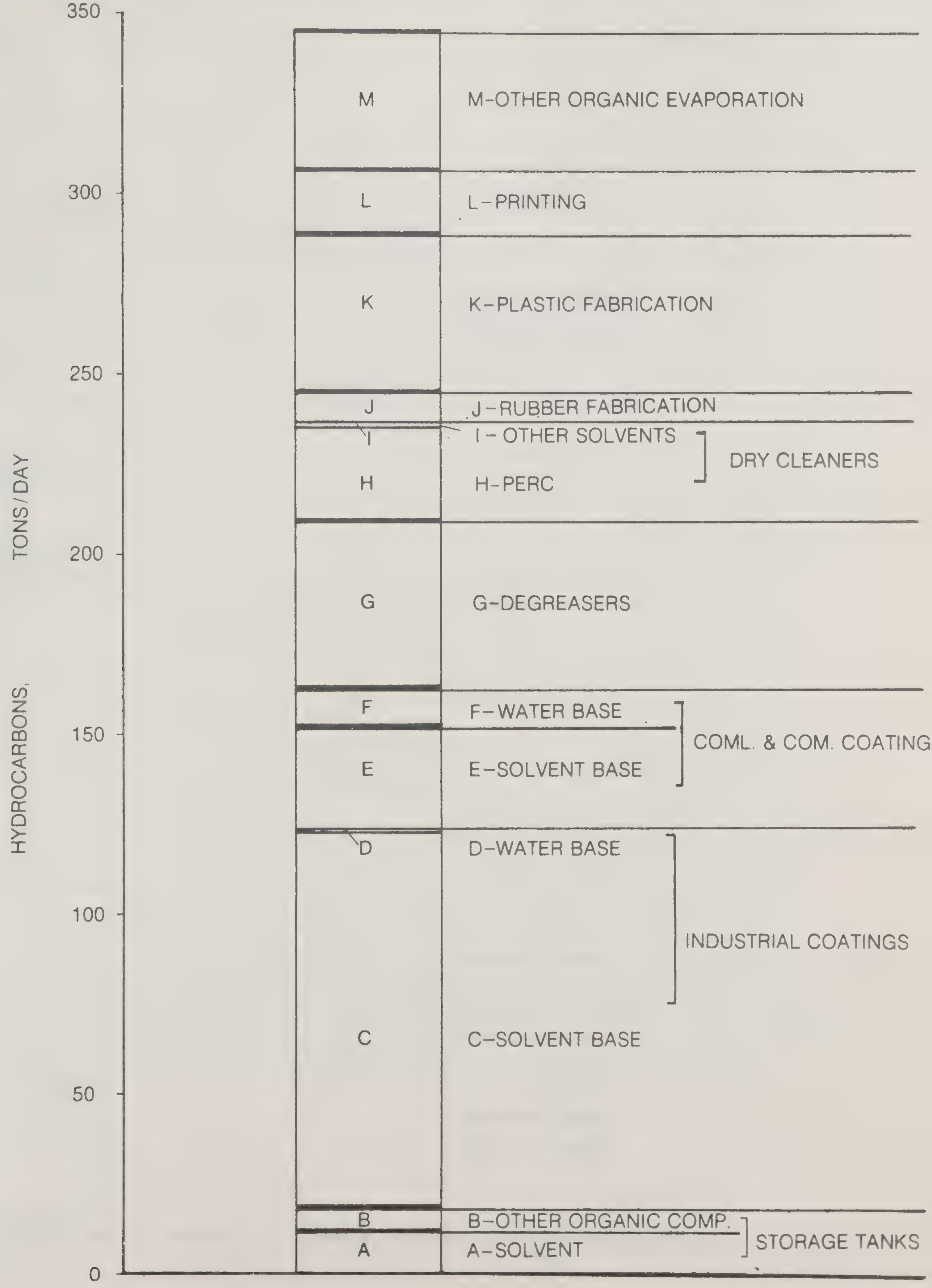
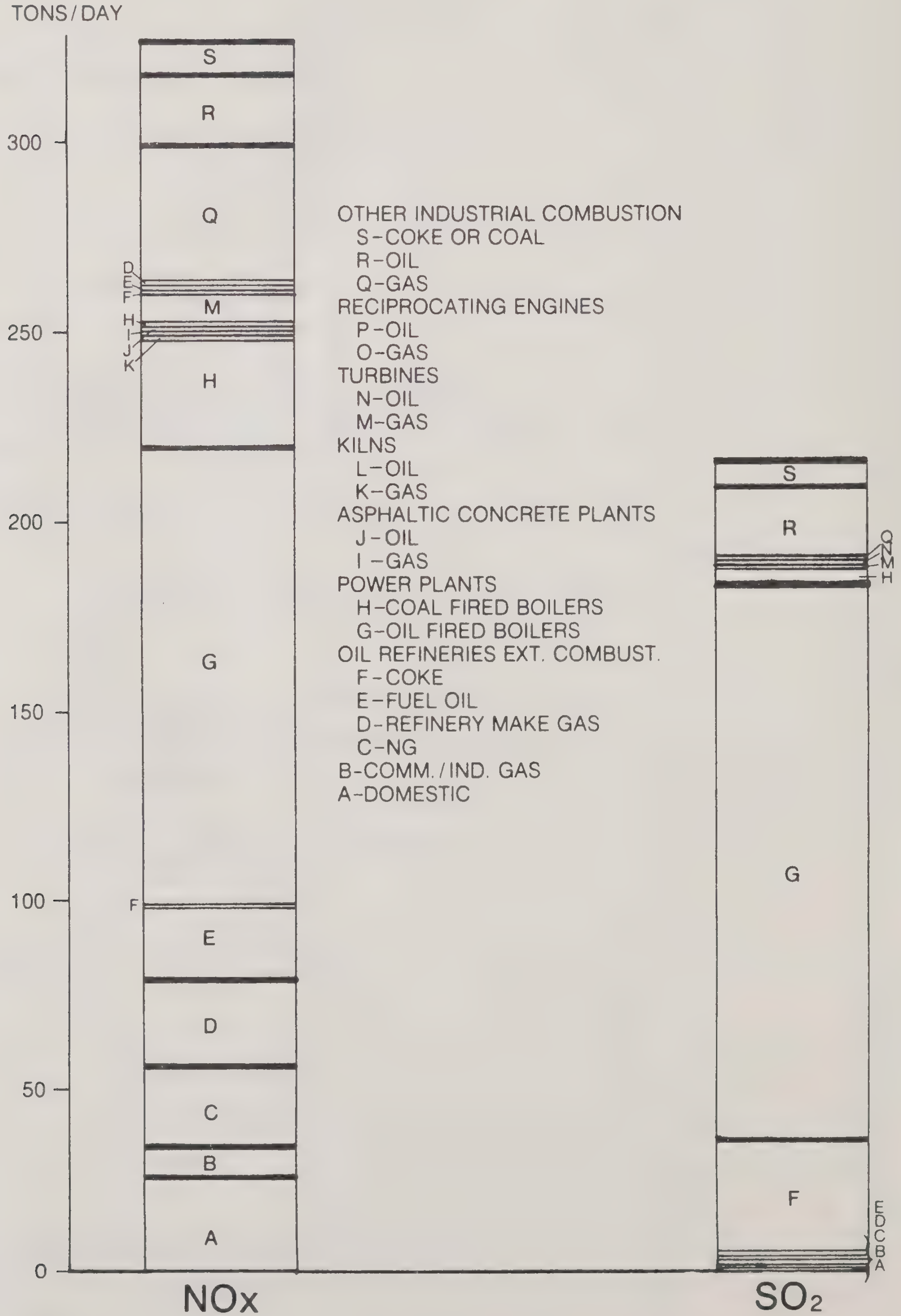


Figure – 18

## BREAKDOWN OF FUEL COMBUSTION EMISSIONS BY SOURCE TYPE IN 1985



## AIR QUALITY TRENDS

Based on historical air monitoring data, the emission inventory projections, and air quality models, it is possible to forecast air quality trends. These trends project future air quality assuming no additional controls beyond those in place or scheduled.

- Sulfur dioxide - Sulfur dioxide emissions are projected to double by 1985, due primarily to the expected switch from natural gas to fuel oil and coal in electric utility and industrial boilers. Consequently, it is expected that $SO_2$ levels will increase substantially. The increased emissions are not projected to result in violations of the Federal standards. Recently, California revised its standards for $SO_2$. This revision complicates the assessment of the impact of emission increases on compliance with the $SO_2$ standard because it is now dependent on oxidant and particulate levels. Neither historical data bases nor available modeling techniques are ready to address the new standard at this time. A more detailed assessment of the State $SO_2$ problems projected is recommended for the continuing planning process.

- Total suspended particulates - Emissions of particulate matter are projected to increase steadily from 1975 to 2000. As previously described, both Federal and State standards for particulates are violated in the region by a small margin. The significance of the increased emissions with respect to future violations cannot be assessed with existing data. The two largest components of particulate matter in the Bay Area's atmosphere are organic matter and dust. The development of a control strategy must await the collection of more refined data to identify the nature and sources of particulates in the air. The research work to obtain this data is recommended for the continuing planning process.

- Carbon monoxide - By far the dominant source of carbon monoxide emissions is motor vehicles. The number of vehicles and the number of miles driven in the region are projected to increase by about 70 percent between 1975 and 2000. Total regional CO emissions are projected to decline steadily from 1975 to 2000, despite the projected increase in vehicle miles travelled. However, this decline is not expected to be sufficient to meet CO standards. It appears the emission control technologies currently used for automobiles and trucks may not be sufficient to prevent continuing violations of the CO standard in the Bay Area. CO problems are localized and occur in relatively few areas of the region. Solutions to these problems require a case by case analysis of the causes of the problems. The current AQMP effort has not conducted any detailed CO studies at a local level. These are recommended as part of the continuing planning process.

- Nitrogen dioxide - The Federal standard for nitrogen dioxide is not currently violated. In addition, the emission inventory projection for $NO_x$ does not indicate a significant increase in $NO_x$ emissions. The conclusion is therefore that no future violations of the nitrogen dioxide Federal standard are expected. California has a 0.25 ppm one-hour average $NO_2$ standard. In 1976, this standard was violated several times in a few Bay Area locations. These violations are suspected to be mobile source related. If this is the case, the current CARB controls for $NO_x$ emissions from motor vehicles may solve the $NO_2$ problem. The analysis of oxidant control strategies shows additional controls of $NO_x$ emissions beyond those currently planned for will worsen the oxidant air quality in the Bay Area. Because of the potentially counter-productive aspects of such controls, no additional $NO_x$ controls are proposed, while hydrocarbon emissions are to be reduced by 43% to meet the oxidant standard by 1985-87. Whether or not additional $NO_x$ controls are needed is discussed in Section H. The implications to be drawn are that hydrocarbons should be stringently controlled and that care should be exercised in deciding how much control of oxides of nitrogen emissions is appropriate. Technically, this is the most controversial issue facing the Bay Region in dealing with the requirements of the Clean Air Act for attainment and maintenance of the oxidant standard.

- Photochemical Oxidants - Oxidants (primarily ozone) are formed in the atmosphere from emissions of hydrocarbons and oxides of nitrogen. From the emission inventory projections, hydrocarbon emissions are expected to decline moderately by 1985, and to rise back to the 1975 level by the year 2000. Oxides of nitrogen are projected to remain relatively constant from 1975 to 2000. These projections suggest that oxidant levels will be moderately reduced (an approximate 10 to 20 percent improvement) by 1985, but this improvement will not be maintained through the year 2000. Air quality data collected over the past several years indicate a slow trend toward lower oxidant levels and it is expected that this trend will continue for several more years. Somewhere around 1985, the trend will reverse if no further controls are implemented. Since oxidants are generally considered to be the most serious regional air quality problem, it has been analyzed extensively in this program. Most of the remaining report deals with the oxidant problem and recommended strategies for solving it.

# Section-E

# PHOTOCHEMICAL OXIDANT TRENDS

Photochemical oxidants (consisting primarily of ozone) are formed in the atmosphere from emissions of hydrocarbons and oxides of nitrogen. The recent history of violations of the Federal oxidant standard in the Bay Area as shown in Table 10, and as summarized in the previous section, indicates the severity and extent of the problem. The wide variety of sources which emit hydrocarbons to the atmosphere make the development of appropriate control strategies a complex task. Each of the major source categories of hydrocarbon emissions has been subject to previous control efforts, and these efforts have to date resulted in a gradual improvement in measured oxidant levels.

From the emission inventory projections, hydrocarbon emissions are expected to decline moderately by 1985, and to rise back to the 1975 level by the year 2000. Concurrently, oxides of nitrogen emissions are projected to remain relatively constant over the same period. This section describes the implications of these projected emission trends on future oxidant levels if no further controls are adopted beyond those now being implemented. This projection is also referred to as the "baseline" air quality projection.

## THE LIVERMORE REGIONAL AIR QUALITY MODEL (LIRAQ)

Complex atmospheric and chemical relationships combine to determine air quality on an urban and regional basis. The use of sophisticated planning and analysis tools is necessary for developing information to guide in making decisions that will affect this air quality. The set of computer codes, which together comprise the Livermore Regional Air Quality (LIRAQ) model, have been developed as an operational tool to assist air quality planners and control agencies in tasks such as assessing the compliance of present air quality with Federal ambient air quality standards, evaluating the impact on regional air quality of various land use alternatives, and predicting the effect on regional air quality of new sources and various control strategies.

The LIRAQ model has been developed by the Lawrence Livermore Lab (LLL) with the support of the National Science Foundation (NSF) and in cooperation with the Bay Area Air Quality Management District (BAAQMD). The BAAQMD has provided a detailed source inventory and much of the information needed to compare the numerical mode predictions with observations. It is also the initial user agency. Also involved were the NASA Ames Research Center, which used its instrumented aircraft to gather data for model comparison with observation.

The LIRAQ model attempts to treat most of the important factors that determine regional air quality as a function of time. The region of initial interest, the San Francisco Bay Area, is characterized by both its complex topography and its changing meteorology. As shown in Figure 19, the region has quite intricate geographic features, including

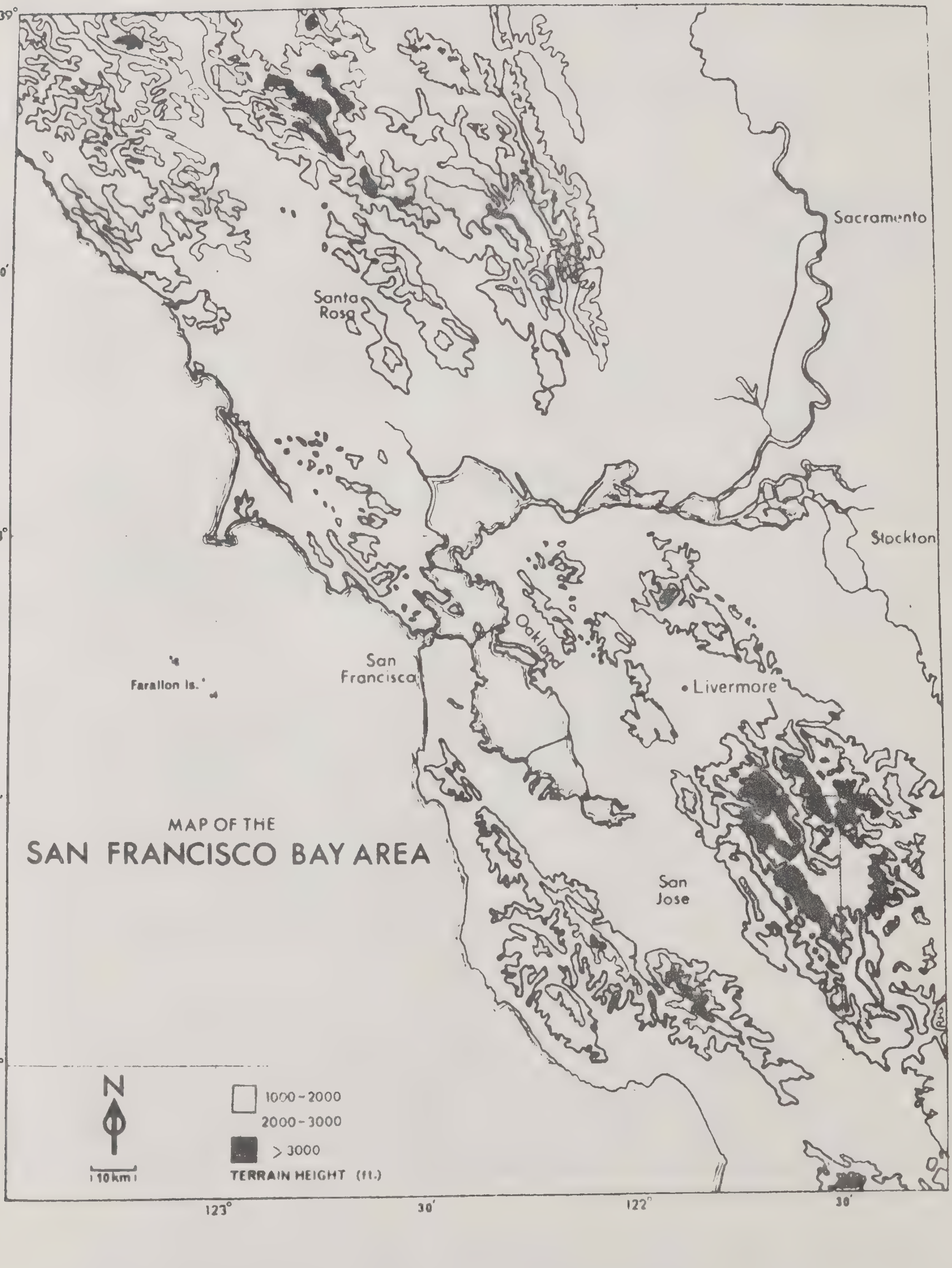



Figure 19. Topography of the San Francisco Bay Area

numerous ridges, hills, valleys, the Pacific Ocean, a central bay, and major inland flats. Meteorological systems formed over the Pacific Ocean are influenced by the complex Bay Area topography to create complicated, temporally and spatially varying wind fields, and inversion base heights. The model treats both the complex topography and changing meterology on one of several available grid scales (1 km or greater) from which the user may choose to study a particular air quality problem. The model does not attempt to forecast tomorrow's air quality, because that would require the capability to forecast the regional meteorology, a formidable problem in itself. Instead, in LIRAQ, the meteorology must be specified, either at measurement stations or by coordinates. Typically, this involves use of either real or hypothetical meterological situations (based on sets of previously acquired meteorological observations) that may be expected to be similar to future weather patterns.

The air quality region capable of being studied is based on the boundaries of the BAAQMD and encompasses all or parts of nine counties.

Within the approximate 14,000 $km^2$ of the BAAQMD, the emission of pollutants is spread in a non-uniform pattern over the region of interest. The model deals with four separate types of pollutant sources:

- Mobile (using emissions derived from a traffic model that represents the Bay Area traffic network using about 13,600 highway links and simulates hourly loading--compiled by ABAG, MTC, and the CARB).

- Point (based on a compilation of major point sources from the BAAQMD with an hourly emission cycle and differentiating between surface and elevated).

- Airport (treated as limited-area surface sources with estimated hourly air traffic loading).

- Area (based on a distribution of estimated emissions using data from ABAG's Series 3 projections).

The pollutant species of interest in studying the regional air quality in the Bay Area can be divided into primary and secondary species. The primary species (meaning those which have identifiable man-made sources) that the LIRAQ model can treat are carbon monoxide (CO), nitric oxide (NO), and hydrocarbons (HC). Based on the particular reaction set used in this model to treat photochemical air quality, hydrocarbons are divided into three characteristic types based on their reactivity: HC1 (mainly alkenes), HC2 (mainly alkanes, simple aromatics, ethers, alcohols, etc.), and HC4 (mainly aldehydes, some ketones, some aromatics). In addition, secondary species (those created through chemical transformation processes in the atmosphere) including ozone ($O_3$), nitrogen dioxide, ($NO_2$), and others must be and are treated by the LIRAQ model.

The LIRAQ model is capable of simulating the time- and space-varying concentrations of non-reactive and reactive pollutants on a regional

TABLE 10. SUMMARY OF RECENT PHOTOCHEMICAL OXIDANT AIR QUALITY IN THE SAN FRANCISCO BAY AREA

| | 1974 | | 1975 | | 1976 | |
|---|---|---|---|---|---|---|
| | Oxidant Highest Hourly Average (in pphm) | Number of Days Federal Oxidant Standard Was Exceeded | Oxidant Highest Hourly Average (in pphm) | Number of Days Federal Oxidant Standard Was Exceeded | Oxidant Highest Hourly Average (in pphm) | Number of Days Federal Oxidant Standard Was Exceeded |
| San Francisco | 14 | 4 | 5 | 0 | 13 | 2 |
| San Rafael | 12 | 8 | 13 | 1 | 12 | 5 |
| Richmond | 11 | 1 | 10 | 2 | 13 | 7 |
| Pittsburg | 15 | 30 | 14 | 10 | 15 | 29 |
| Concord | 16 | 35 | 15 | 5 | 17 | 24 |
| Walnut Creek | 15 | 31 | 17 | 21 | 14 | 10 |
| Oakland | 13 | 6 | 10 | 2 | 15 | 6 |
| San Leandro | 18 | 31 | 15 | 14 | 16 | 9 |
| Hayward | 23 | 48 | 23 | 28 | 18 | 30 |
| Fremont | 22 | 61 | 20 | 23 | 16 | 21 |
| Livermore | 28 | 93 | 17 | 28 | 17 | 29 |
| San Jose | 28 | 87 | 19 | 48 | 17 | 32 |
| Alum Rock (NS) | 24 | 96 | 23 | 49 | 16 | 31 |
| Gilroy (NS) | 17 | 63 | 14 | 21 | 21 | 30 |
| Los Gatos | 25 | 69 | 15 | 34 | 14 | 19 |
| Sunnyvale | 18 | 46 | 22 | 14 | 15 | 22 |
| Mountain View | 15 | 18 | 21 | 17 | 14 | 11 |
| Redwood City | 18 | 20 | 13 | 14 | 17 | 16 |
| Burlingame | 16 | 18 | 9 | 1 | 15 | 3 |
| Petaluma | 14 | 13 | 11 | 1 | 9 | 5 |
| Santa Rosa | 10 | 6 | 10 | 3 | 9 | 1 |
| Sonoma | -- | -- | 17 | 20 | 13 | 21 |
| Napa | 13 | 32 | 17 | 25 | 12 | 16 |
| Vallejo | 16 | 28 | 16 | 10 | 18 | 21 |
| Fairfield | 15 | 38 | 11 | 15 | 14 | 17 |

Source: Bay Area Air Quality Management District

basis using prescribed meteorology and source emissions. The basic types of questions that the model has been designed to deal with can be derived into three categories:

- Assessment of present air quality: By inputting to the model the present regional pattern of source emissions, the air quality on specific days can be simulated. While observations from monitoring stations do provide an indication of present air quality at a few points (observations with which the model results may be compared), the model also indicates what the air quality is at locations between such observation sites. Such results may thus point to regions where more extreme air pollutant concentrations may prevail than are being measured. Such information may then assist in locating monitoring stations or indicate where mobile measurement stations should sample.

- Development of emission control strategies: For regions which do not meet the Federal air quality standards, the development of control strategies is an important consideration. A variety of model simulations may prove useful, depending on the time and spatial scale of the problem. One application might be to determine the relative role played by various types of sources--mobile, point, airport, and area--in degrading regional air quality. Another subject to investigate might be the relative importance of various species, as for example the importance of hydrocarbons with different reactivities. With such information, control strategies could be proposed and their effect simulated in order to determine the sense and magnitude of the effect.

- Planning for future air quality: Although control of emissions is the primary way to improve present air quality, proper planning of the locations, extent, and mix of future pollutant emissions is believed to be useful in assuring that future air quality meets appropriate standards. More specifically, the effect on air quality of a proposed source of subregional significance can be evaluated. In addition to investigating land use, planning for potential changes in fuel usage can be undertaken. For example, the potential effect of substituting fuel oil for natural gas could be simulated, assuming emission data can be specified.

The range of problems that are being addressed by air quality planners is very broad. The current effort has addressed many of the issues regarding oxidant control strategies. Many more issues still remain to be investigated. The following sections describe much of the technical support analysis leading to recommendations for a comprehensive control strategy to solve the region's oxidant problem.

## BASELINE PHOTOCHEMICAL OXIDANT TRENDS

Using prototype meteorological data and the emissions inventory projections previously described, photochemical oxidant forecasts were made for the Bay Area for 1985 and 2000. These results are presented in Tables 11

Table 11. Bay Area Baseline LIRAQ Projections (1975-2000)

| | 1975 | 1985 | 2000 |
|---|---|---|---|
| Location of Regionwide High Hour Ozone | 9.5 Kms SSE of Livermore | 9.5 Kms SSE of Livermore | 9.5 Kms SSE of Livermore |
| Regional High Hour (ppm) | .17 | .13 | .17 |
| Monitoring Station with Highest Ozone | Livermore | Livermore | Livermore |
| Ozone at Highest Station (ppm) | .13 | .10 | .13 |
| Projected Ozone Maximum at Individual Stations (ppm) | | | |
| San Francisco | .02 | .02 | .02 |
| San Rafael | .02 | .02 | .05 |
| Pittsburg | .04 | .03 | .05 |
| Livermore | .13 | .10 | .12 |
| Fremont | .07 | .05 | .06 |
| San Jose | .13 | .09 | .13 |
| Redwood City | .09 | .06 | .07 |
| Concord | .06 | .05 | .06 |
| Richmond | .04 | .03 | .04 |
| Half Moon Bay | .03 | .03 | .03 |
| San Leandro | .07 | .05 | .06 |
| Los Gatos | .07 | .05 | .07 |
| Vallejo | .05 | .04 | .04 |

NOTES: 1) Prototype day assumed is July 26, 1973. On this day the maximum oxidant level recorded was 0.18 ppm monitored in Livermore.
2) The Federal photochemical oxidant standard is 0.08 ppm - one hour, not to be exceeded more than once per year.
3) Projections presented are uncorrected for worst case conditions.

and 12. These projections show that regional oxidant is expected to improve between 1975 and 1985 by approximately 20%. This improvement is anticipated largely because of the Federal and California motor vehicle control programs. Between 1985 and 2000, however, due to growth in population, motor vehicles, and normal urban activities (e.g., painting, printing, dry cleaning), the oxidant is projected to deteriorate to about 1975 levels again. Figures 20-22 show LIRAQ projection results for 1975, 1985, and 2000 in the southern parts of the region.

LIRAQ is somewhat limited in the areas it can simulate during any one run. Table 11 presents results of the southern bay areas while Table 12 presents data for the north bay counties. The north bay results should be viewed with caution since the prototype meteorology assumed for the analysis is not indicative of adverse meteorological conditions which have been experienced in the north bay. The north bay results do show, however, the trends generally predicted for the entire bay region. Between 1975 and 1985, most north bay areas will experience modest improvements in oxidant. This improvement will reverse itself around 1985, until oxidant levels in 2000 deteriorate back to 1975 levels.

## Major Assumptions Used in the Baseline Oxidant Trends

Any projections of future conditions requires that certain assumptions be made. For air quality projections, many assumptions are made regarding future conditions. As subsequent plan updates are prepared, these assumptions need to be reviewed. New information and/or circumstances should be incorporated to AQMP updates so that the control strategies being applied can be examined for their overall effectiveness. As appropriate, new programs may need to be implemented. Conversely, control programs in effect can be reexamined to see if they are still needed. This section describes the major planning assumptions that were used to produce the baseline oxidant projections.

*Population, Housing, Employment, and Land Uses*. The "Provisional Series 3 Projections" (March, 1977) were generally used as the basis for demographic data needed. In particular, the upper range (commonly referred to as Base Case 1) of population was used. In 2000, it was assumed the region would grow to approximately 6.1 million people. (In the strategies analyzed for air quality improvement, the lower population assumption of 5.4 million people in 2000 was also analyzed for its air quality implications.)

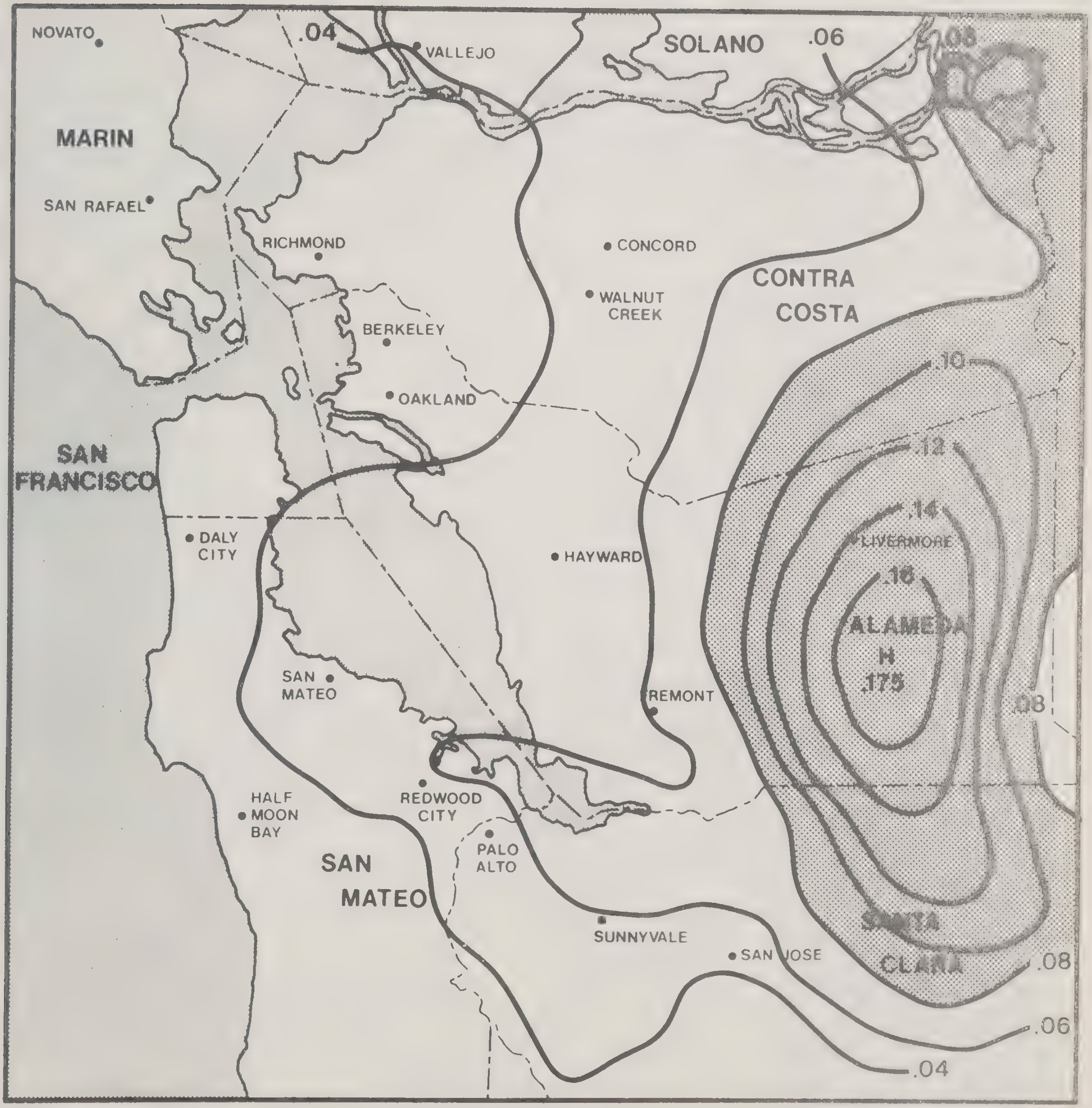
*Emission Inventory Projections*. Emissions projections for stationary source and aircraft have been made by the BAAQMD, and are documented in several publications, e.g., "Emission Inventory Summary Report" (August 1976) and "Method of Projection" (May, 1977). Generally, the projections assume "normal" growth in the region consistent with the demographic projections made by ABAG. Transportation and mobile source emission projections were made jointly by ABAG, MTC and CARB. Again, these projections reflect anticipated growth in the region as forecast in the ABAG Series 3 projections.

Table 12. Bay Area Baseline LIRAQ Projections (North Bay) 1975-2000

| | 1975 | 1985 | 2000 |
|---|---|---|---|
| Location of North Regional High Hour Zone | Napa Airport | 12 Km. ESE Travis AFB | 12 Km. ESE Travis AFB |
| North Regional High Hour (ppm) | .08 | .07 | .08 |
| Monitoring Station with Highest Ozone | Napa Airport | Travis AFB | Napa Airport |
| Ozone at Highest Station (ppm) | .08 | .06 | .07 |
| Projected Ozone Maximum at Individual Stations (ppm) | | | |
| San Francisco | .02 | .02 | .02 |
| Santa Rosa | .04 | .04 | .04 |
| San Rafael | .03 | .03 | .03 |
| Petaluma | .04 | .04 | .04 |
| Napa | .08 | .06 | .07 |
| Sonoma County Airport | .03 | .03 | .07 |
| Pittsburg | .06 | .04 | .05 |
| Hamilton Air Force Base | .03 | .03 | .03 |
| Napa County Airport | .08 | .06 | .07 |
| Concord | .07 | .05 | .06 |
| Richmond | .04 | .03 | .04 |
| Travis Air Force Base | .07 | .06 | .07 |
| Angel Island | .04 | .03 | .04 |
| Point Bonita | .04 | .03 | .04 |
| Fairfield | .06 | .06 | .06 |

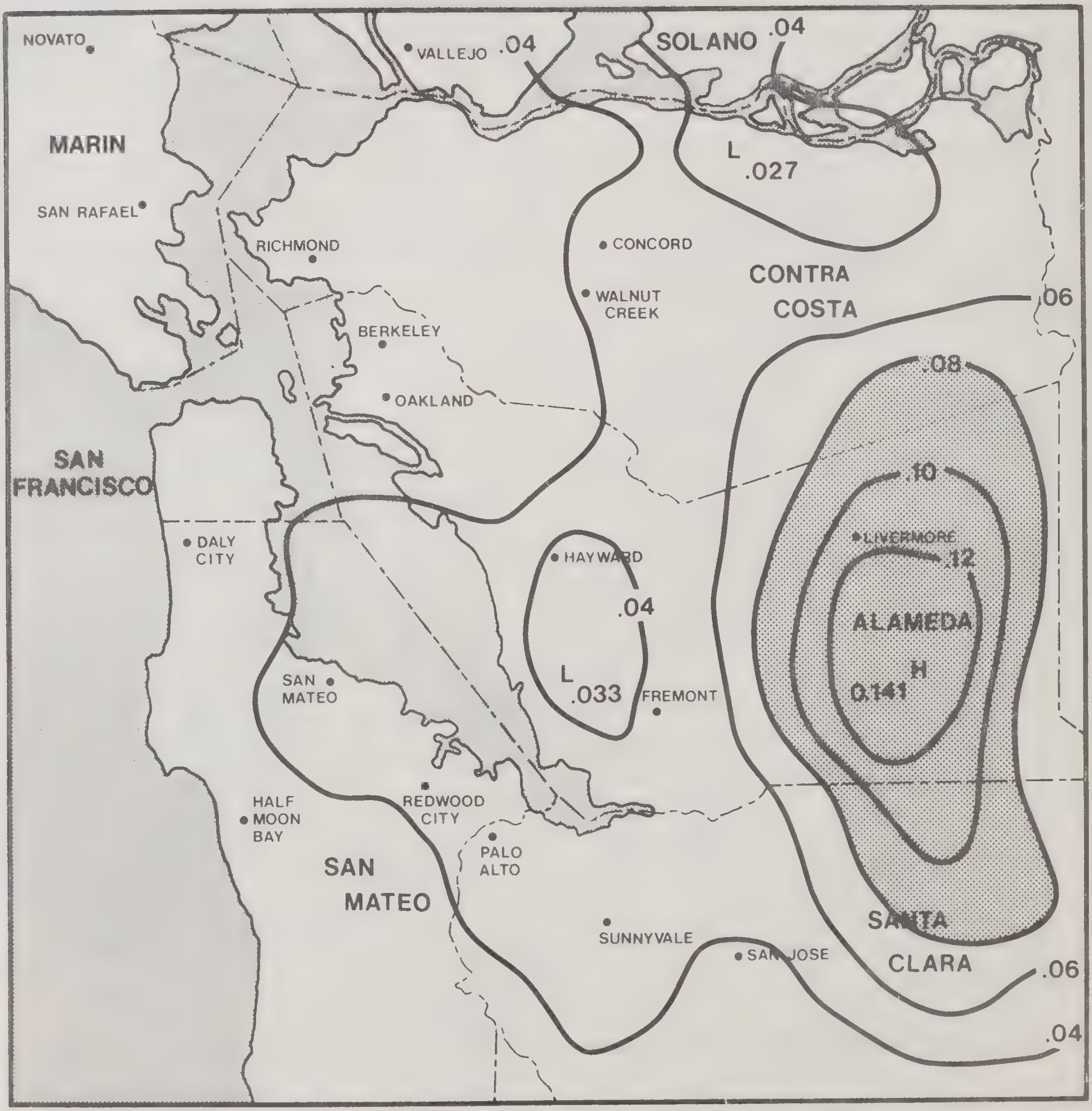
NOTES: 1) Prototype day assumed is July 26, 1973. On this day the maximum oxidant level recorded was 0.18 ppm monitored in Livermore.
2) The Federal photochemical oxidant standard is 0.08 ppm - one hour, not to be exceeded more than once per year.
3) Projections presented are uncorrected for worst case conditions.

Figure 20.. Example LIRAQ Results - 1975 Baseline Ozone Projections



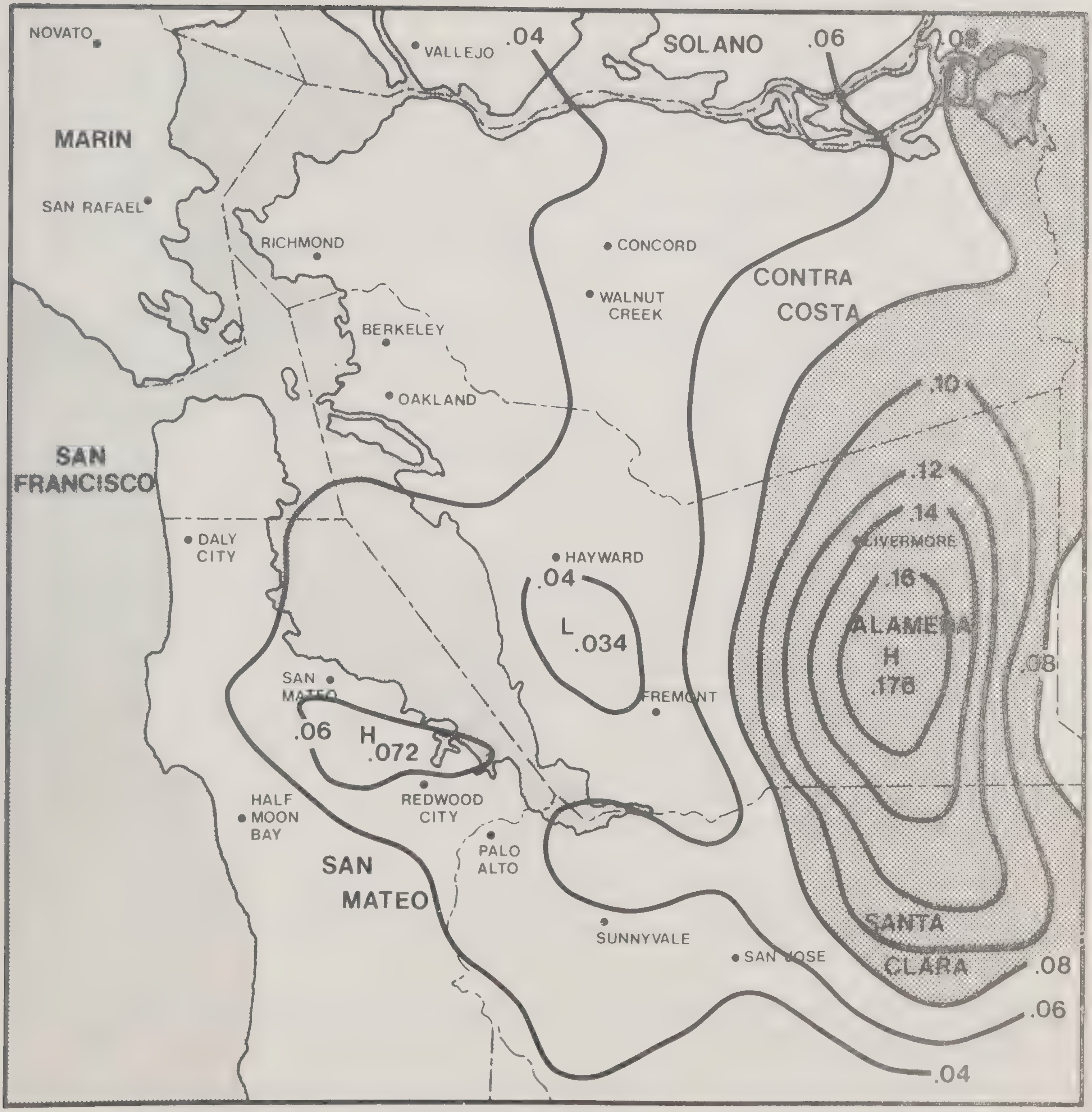

Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Federal oxidant standard is 0.08ppm - 1 hour

Figure 21. Example LIRAQ Results - 1985 Baseline Ozone Projections




Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Federal oxidant standard is 0.08ppm - 1 hour

Figure 22. Example LIRAQ Results - 2000 Baseline Ozone Projections




Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Federal oxidant standard is 0.08ppm - 1 hour

*Meteorological Assumptions*. The data used in the LIRAQ analyses assume July 26, 1973 prototype meteorology. In essence, it assumes the meteorology which occurred on July 26, 1973 is typical of conditions conducive to adverse air quality in the region and capable of being repeated in 1985 and 2000. Additional prototype days are recommended for analysis in the continuing planning process.

*Air Pollution Control Programs*. The plan has assumed that existing control programs would continue to be implemented. It has also assumed that programs adopted for implementation in future years will be carried out as currently scheduled. Of major significance in this latter category are the motor vehicle emission control programs of EPA and the CARB.

In general, the air quality baseline projections assume air pollution control programs currently "on the books" or adopted and scheduled for implementation. There is one exception and it is an important one. The BAAQMD has had in effect for a number of years Section 1309 of Regulation 2; this regulation requires a permit review of new or modified sources of pollution (the new source review program is commonly referred to as the NSR regulation). The NSR regulation can have a variable impact on air quality depending upon the stringency of the rule adopted, the amount of off-set required, the conditions for issuing or denying permits, and the response of new and existing industries to the requirements.

Because the NSR rule is so difficult to predict (i.e., being a review program with variable impact), all the projections made by ABAG, MTC and BAAQMD were consistent in assuming no NSR rule for the baseline projections. As described later, the effectiveness of NSR is assumed in the alternative control strategy analyses. The fact that this program can have a variable air quality impact provides the plan with flexibility in later years. This assumption and its importance in the overall strategy recommended is explained further in Sections H and I.

Uncertainties in Assumptions and Analysis

There are two basic sources of uncertainty in the plan: uncertainties related to the projections and those arising from inaccuracies in the data and analysis tools used. Each of these sources should be considered in formulating the plan's control strategies.

It should also be noted that uncertainties usually occur in two directions: They may result in either underestimates or overestimates of the control programs needed.

*Forecasting Uncertainties*. To prepare a long-range plan for attaining and maintaining air quality standards it is necessary to forecast what future air quality is likely to be, as well as what sources will contribute most significantly to future air quality problems. Such a forecast is required by federal regulations. In making these forecasts, a variety of assumptions must be made regarding how the region

will grow, how effective existing air pollution control programs will be, and how future resources will be consumed. These assumptions have been documented in various AQMP Tech Memos, Issue Papers, and Projections Technical Advisory Committee (PTAC) Working Papers. Each assumption reflects some judgment, and alternative assumptions are always possible. The forecasting process was designed to explicitly identify and discuss such assumptions before completion of the analysis, thus ensuring as much objectivity as possible.

The resulting forecasts indicate the most likely future of air quality in the region under various conditions. It is possible that trends will change or unexpected events will occur which would invalidate the forecasts. This is one reason for establishing a continuing planning program, for which the current plan would be an initial effort. In the meantime, decisions made now can and will affect future air quality. Despite the many assumptions which are made, a rigorous, objective forecast is a necessary key element of the plan.

*Analytical Uncertainties*. Independent of the difficulties related to forecasting future conditons are uncertainties inherent in the forecasting models. Models are used to better understand complex problems such as air pollution. Air quality models always have and will continue to contain inherent imperfections--this is a reflection of practical constraints on data acquisition, computer capacity, and the state of knowledge on the complex processes involved.

Despite the imperfect nature of modeling, the models being used in support of the plan are among the most sophisticated and most thoroughly tested models available. Verification tests of model performance have been conducted prior to and as part of the current effort. In addition, appropriate adjustments have been developed to temper model performance according to measured air quality data and expert judgment. The air quality modeling effort undergoes periodic review by a special modeling committee composed of modeling experts from the Lawrence Livermore Laboratory, California Air Resources Board, Bay Area Air Quality Management District, Systems Applications Inc., U.S. Environmental Protection Agency, Metropolitan Transportation Commission, California Department of Transportation, and Association of Bay Area Governments. Thus, the resulting forecasts are as objective, rigorous, and accurate as possible at this time.

# Section-F

# ALTERNATIVE SOLUTIONS TO THE OXIDANT PROBLEM

Air quality improvements can be achieved in many different ways. As previously described, a variety of stationary and mobile source controls have already been implemented. This section inventories many of the still remaining control measures which might be considered for further air quality improvement. Many of the programs which are considered may in fact already be in existence, e.g., transit service, vehicle exhaust emission standards. What is considered then is a further strengthening or expansion of the program in place, e.g., more transit service, lower vehicle exhaust emission standards.

Because so many possibilities exist for consideration, the Joint Technical Staff and later the Air Quality Advisory Committee were involved in screening the control options which were developed. The screening process led to a more manageable number of options which were evaluated further by the Joint Technical Staff. The control measures recommended in Section I represent staff prepared draft proposals reviewed and modified by the ABAG Environmental Management Task Force (EMTF), Regional Planning Committee (RPC), Executive Board and General Assembly. The air quality strategy proposed is intended to meet the program objectives and be acceptable to EPA and CARB.

During the development of the initial staff prepared draft proposals, the Environmental Management Task Force (EMTF) expressed a number of concerns about the measures recommended and how they were arrived at. These concerns can be summarized as follows:

- Completeness of the options considered.
- Process for screening the options.
- Criteria used to screen the options.
- Need for EMTF and other policy making bodies to have a wide range of options to choose from in development the plan recommendations.

This section attempts to address all of the concerns expressed by EMTF, RPC, and the Executive Board of ABAG. Both the process and the rationale used by staff to arrive at the plan's recommendations are presented. The draft plan was debated by EMTF, other policy making bodies and various public and special interest groups during the public hearing. As a result of comments, numerous changes to the plan were made. This section includes documentation of the major changes made to the plan as it has evolved from a draft plan to the current plan recommendations.

INVENTORY OF OPTIONS (OR CANDIDATE CONTROL MEASURES)

The first step in the process of developing alternative solutions to the air quality problems was to prepare an inventory of options (also referred to as the candidate control measures). The procedure used by the Joint Technical

Staff was to have each participating agency develop a list of options for their area of expertise and/or responsibility. Thus, the work was divided as follows:

| Agency | Area of Expertise/Responsibility |
|---|---|
| Bay Area Air Quality Management District | Stationary Source Controls |
| California Air Resources Board | Mobile Source Controls |
| Metropolitan Transportation Commission | Transportation Controls |
| Association of Bay Area Governments | Land use Management/ Development Controls |

As the inventory of options was being developed, input was requested from the Air Quality Advisory Committee to ensure the list was complete as possible.

Completeness of Options Considered

Because of the very wide range of options which could have an impact on air quality, it is impossible to compile an absolutely complete list of options. However, the Joint Technical Staff did compile an exhaustive list of options. These options were generally viewed by staff as offering potential air quality improvement and worthy of some level of technical review and analysis.

As an example of how options were viewed to be incomplete, an Air Quality Advisory Committee member felt "population measures" should be considered in the AQMP. Later, when this issue was discussed by the EMTF, it was generally agreed that population control measures were inappropriate as a serious or viable options for improving air quality. Rather what needed to be spelled out to EMTF and the public were the air quality implications of the high and low population range forecast for the region. This has been done by staff.

The plan takes into consideration the inherent uncertainty of population forecasts. For the year 2000, both the high (approximately 6.1 million people) and low (approximately 5.4 million people) populations are projected to be equally plausible. Stated differently, either projection or anything in between is likely to occur given our current trends. The air quality implications are also clear. More people will mean more air pollution. All other things being equal, air quality will be worse in 2000 with 6.1 million residents than with 5.4 million residents.

To achieve the same level of air quality, the implication is a higher level of control will be needed to accommodate more people. Conversely, a lower level of control will be needed if there are fewer people in the region. The plan recommendations provide for flexibility to deal with this inherent uncertainty and yet provide for meeting and maintaining the air quality standards.

Other examples of control measures the EMTF wanted considered in the process were:

- Fuel rationing (including gasoline rationing).
- Energy conservation (industrial and residential).
- Indirect source review (as an enforcement mechanism to implement the land use management and development controls).

These control measures and several others are discussed in the following section.

## Control Measures Considered

Table 13 lists the inventory of air pollution control measures considered in developing the plan. The inventory is organized according to the participating agencies that prepared the component parts.

The control measures for stationary and mobile sources have traditionally been direct controls. As such they can be specified quite precisely. Many of the transportation controls and land use management measures are indirect controls. Thus, they tend to be described in more general terms. This is especially true for the land use management actions proposed. The objective of the land use management program was to reduce the number and length of automobile trips and to increase transit use in order to decrease the amount of regional automobile travel. This was to be accomplished by ahcieving more compact development in the region by the year 2000. Recommendations were presented for policies and actions that might begin to achieve these objectives. Clearly there may be other policies and actions that could ahcieve the stated objectives. What elected officials and the public had to determine is how to achieve the objectives in the most efficient manner acceptable to local governments and the general public.

## PROCESS FOR SCREENING THE OPTIONS

Having developed an inventory of about 100 control measure options, the Joint Technical Staff proceeded to screen the options down to a more manageable size. Again, the agencies that developed the initial lists were primarily responsible for the initial screening. During the screening process the Air Quality Advisory Committee was also asked to comment on which measures should be included for more detailed study. They were also given the opportunity to suggest other measures which may have been left out of the original inventory.

In conducting the screenings, the Joint Technical Staff attempted to avoid political judgments regarding a measure's implementability. The list of control options was screened primarily on the basis of technical effectiveness. Gas rationing could be an effective way of controlling air pollution. The debates about gas rationing center on its public and political acceptability and implementability. The Air Quality Advisory Committee argued over whether gas rationing should or should not be screened out. In the end it was included in the screened options because it is technically effective. Elected officials and the public could judge its political merits and public acceptability.

## Table 13. Inventory of Air Pollution Control Measures

### I. Stationary Sources

1. Require the use of high solid coatings where practical.
2. Require the use of water based coatings where practical.
3. Adopt the CARB standards for organic liquid storage.
4. Adopt closed system organic liquid storage with vapor recovery.
5. Require vapor recovery on small solvent users.
6. Adopt organic solvent regulation developed by the CARB Organic Solids Committee.
7. Enact a new maximum $SO_2$ emission limit of 300 ppm.
8. Require reduced sulfur content in fuels to .025%.
9. Adopt $NO_x$ controls for non-highway and construction equipment.
10. Adopt $NO_x$ limits for all new boilers.
11. Adopt lower particulate loading requirement - 0.05 to 0.1 grains/SCFM.
12. Adopt lower process weight allowable scale.
13. Adopt lower process weight maximum allowable scale.
14. Adopt best available control technology (BACT) regulation for existing sources with a time scale for compliance.
15. Adopt BACT regulation for all sources in lieu of emission concentration limits.
16. Adopt BACT regulation for all sources in addition to emission concentration limits.
17. Adopt a modern process technology rule aimed at promoting modernization of the areawide plant. This might, for instance, suspend a BACT rule for an agreement to modernize a plant with BACT included in modernized version. The intent of such a regulation would be to encourage modernization of old plants with new plants having improved pollution control technology.
18. Extention of current BAAPCD requirements to smaller operations, i.e., fewer exemptions.
19. New Source Review (NSR) - continue present rule.
20. New Source Review - Adopt 100% off-set policy.
21. New Source Review - Adopt 110% off-set policy.
22. New Source Review - Adopt a sliding scale for emission off-set.
23. NSR Options 20, 21 or 22 with a limited area for emission off-set.
24. NSR Options 20, 21 or 22 with inter-pollutant emission off-set.
25. NSR Options 20, 21 or 22 with no inter-pollutant off-set or inter-pollutant off-set governed by location, etc.
26. NSR Options 20-25 qualified so that no credit is allowed for emissions that are in excess of other limitations.
27. NSR Options 20-25 with arrangement for off-set banking, allowing a prospective new source credit for emission reduction off-set achieved beyond that required by existing regulations.
28. Adopt regulations to promote industrial energy conservation.
29. Plant operation scheduling:
    a) Seasonal scheduling to reduce polluting operations during critical weeks or months as determined by meteorology.
    b) Scheduling maintenance down time and vacations, possibly short downs, to reduce pollutant load at critical times.
    c) Interruptable operation dependent upon air quality conditions.
    d) Stagger operations between plants to spread operation over seven days instead of five. Assign plants a 5 day week starting on any-one of the seven days, possibly with some on 4 day 10-hour operation.
    e) Stagger work hours. For instance, run coating lines only between 4 PM and midnight instead of 7 AM to 3 PM.
    f) Schedule reduced work days during the smog season with or without longer days during less critical seasons. Rationing the pollution absorbing capacity.
30. An air monitoring and meteorological analysis to identify and recommend mitigation measures, for certain localized problems.
31. Adopt particulate regulation based on particle size.
32. Replace throw-away container with re-usable containers.
33. Burn solid waste near point of generation, to reduce long hauls.
34. Apply 1309 with modified trade-off of 1311 and 1311-2 clearly described as an option.
35 Requiring some sort of retrofitting on older plants. Apply BACT to newer plants through permit system.
36. Penalty charge or tax based on amount of emission to encourage reduction.
37. Lowering the reid vapor pressure of gasoline to reduce hydrocarbon emissions from storage, handling and use of motor vehicle grade gasoline.

### II. Mobile Sources

1. Implement an evaporative emissions retrofit program for all vehicles.
2. Implement a catalytic retrofit program for past-71' vehicles able to operate on unleaded gasoline.
3. Adopt more stringent application of compliance procedures.
4. Adopt more comprehensive new and used motor vehicle surveillance program.
5. Adopt a mandatory vehicle inspection and maintenance program for light and heavy duty vehicles.
6. Adopt more stringent evaporative emission standards.
7. Implement a heavy duty gasoline exhaust emission retrofit program.
8. Adopt more stringent exhaust emission standards for new light and heavy duty vehicles.
9. Promote the use of new or modified fuels.
10. Promote the use of alternative power sources.
11. Establish emission standards for other mobile sources such as construction equipment, locomotives, ships, or recreational vehicles.

## III. Transportation Controls

1. Measures to Improve Traffic Operations

   A. Improve Traffic Flow

      1) Computerized traffic control
      2) Ramp Metering
      3) Traffic engineering improvements
      4) Off-street freight loading

   B. Reduce peak-period traffic volumes

      1) Staggered work hours
      2) Four day work week
      3) Off-peak freight delivery

2. Measures to Reduce Vehicle Use

   A. Restrict Vehicle Ownership

      1) Additional license fee
      2) Registration limits

   B. Management of Auto Access

      1) Better enforcement of parking regulations
      2) Limit on number of parking spaces
      3) On-street parking prohibited during peak hours
      4) Area license
      5) Auto-free zones
      6) Gas rationing

   C. Increase Cost of Auto Use

      1) Road pricing
      2) Increased parking costs
      3) Parking fee for shopper
      4) Eliminate free employee parking
      5) Increased gas tax
      6) Increased tolls
      7) "Smog charges"

   D. Reduce the Need to Travel

      1) Communications substitutes
      2) Goods movement consolidation

3. Measures to Encourage Alternative Model of Travel

   A. Increase Transit Ridership

      1) Additional transit service
      2) Fare reductions
      3) Improved comfort
      4) Bus and carpool lanes

   B. Encourage Pedestrian Mode

   C. Encourage Bicycle Mode

   D. Encourage Ride Sharing

      1) Toll reduction for carpools
      2) Preferential parking and carpools
      3) Carpool matching information
      4) Assist vanpool formation

   E. Promote Para-Transit Alternatives

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## IV. Land Use Management/ Development Controls

More effective management of all five major aspects of land development through coordinated action by cities, counties, special districts, or regional and State agencies to reduce the magnitude and frequency of auto travel:

1. Timing - expand the presently very limited application of timing controls such as growth sequence zoning, building permit quotas, staging of sewer and water intrastructure and plant capabilities, etc.

2. Quantity - expand the presently scattered application of quantitative controls on development such as performance standard zoning and limited sewer and water infrastructure and plant capacities.

3. Location - Improve the presently inconsistent application of controls on the location of development such as coordinated management of infrastructure location, annexations, public land acquisition, agricultural preserves, hillside and soil conservation, and development moratoria.

4. Density - Encourage transit usage and other non-auto modes with coordinated density policies among local jurisdictions through the application of innovative density zoning mechanisms (slope density, building height regulations, etc.) fully coordinated with service capacities and commitments.

5. Type - Reduce home-to-work & home-to-non-work travel by encouraging more land use mix, especially in terms of housing/jobs balance.

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The list of screened options was presented to EMTF in June 1977, during a presentation of alternative air quality strategies. At that meeting EMTF approved the screened listing of control measures for use in developing alternative air quality strategies. EMTF reserved the right to consider other measures at a future date, but directed staff to continue the detailed analysis of the measures presented. These control measures were to be grouped into a series of control strategies for testing of their air quality effects. This was done by staff and is described in the following section.

OTPIONS CONSIDERED BUT NOT INCLUDED IN THE PLAN

Using the screened inventory of control measures as a starting point, the Joint Technical Staff analyzed the remaining control options further. Since it was clear by now that the focus was meeting the oxidant standard, additional measures were eliminated. For example, in some of the earlier progress reports, several measures were included to control sulfur dioxide emissions. Since the more detailed evaluation of the sulfur dioxide problem is proposed for the continuing planning process, these measures were dropped from this current plan. Another example of control measures temporarily deferred is the use of best available control technology for sulfur dioxide and particulate controls. The revised best available control technology proposal concentrates on reducing hydrocarbon emissions from a number of categories.

Tables 14-17 summarize the options considered in the plan but not included as part of the plan. EMTF and other policy makers, in considering the stationary and mobile source controls and transportation measures, were asked to address two issues:

- Are there additional stationary and mobile source controls and transportation measures that should be included?

- Are there stationary and mobile source controls and transportation measures that should not be included?

As previously noted, land use management and development controls were considered to achieve specific objectives--reducing the number and length of automobile trips to reduce regional travel. Specifically, a series of policies and actions which could be adopted to reduce vehicle travel were developed.

- Will the proposed land use policies and actions achieve the objective of reducing regional travel?

- Are there other policies and actions which should be included?

- Are there land use policies and actions included which should not be?

In considering the recommendations of the Environmental Management Task Force, the Regional Planning Committee and the Executive Board, the General Assembly adopted certain control measures for the plan, and did not include others. The other measures considered and rejected for the initial plan are summarized in the tables. The General Assembly reserved for itself a right to make other changes in the plan during the continuing planning process, as adopted control measures are examined for their actual effectiveness and as air quality as measures by ozone levels is actually improved. Other control measures may be

determined by the General Assembly to be necessary to maintain the Federal or State standard.

The hydrocarbon-reduction effort deliberately avoided a pre-selection of reduction targets for the transportation and industrial sections. It was thought more appropriate to retain flexibility--particularly in the potential tradeoffs between measures. The planning process began with an inventory of emissions, and determined what reduction was necessary to achieve the oxidant standard. After extensive public review, controls were selected from the different emission sections, sufficient to achieve the required reduction. A number of stationary, mobile source and transportation controls were selected. Transportation controls selected will result in a significant emission reduction from the transportation sector. Thus although a target for transportation control reductions was not assigned initially, the final responsibility is clearly specified in the plan. Section G contains an extensive analysis of the transportation control measures considered in the development of the plan. It was prepared by MTC in December 1978, and also evaluates the transportation control measures as they related to the planning requirements of the 1977 Clean Air Act Amendments.

Table 14. Options Considered But Not Included in the Plan (Stationary Sources)

| | RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|---|
| 1. | Enact new maximum $SO_2$ emission of 300 ppm. | Affects sulfur recovery, sulfuric acid plants and combustion operations burning fuel oil, etc. | 0 | 0 | BAAPCD Engineering Estimate | Deferred for closer examination in the continuing planning process (CPP); this program is directed at controlling $SO_2$. |
| 2. | Reduce fuel sulfur content to 0.25%. | Affects sulfur recovery sulfuric acid plants and combustion operations burning fuel oil, etc. | 0 | 0 | BAAPCD Engineering Estimate | Deferred for closer examination in the continuing planning process (CPP); this program is directed at controlling $SO_2$. |
| 3. | Adopt $NO_x$ controls for non-highway and construction equipment. | Primarily modifications on agricultural tractors, construction equipment, steamships, locomotives and two cycle engines. | 0 | 0 | BAAPCD Engineering Estimate | Possible conflict with the proposed oxidant control strategy. Requires closer examination. |
| 4. | Adopt $NO_x$ limits for all new boilers. | Long term (15 to 30 years) program to require a new $NO_x$ limit on boilers $\leq$ 250 million BTU/hr. rating. | 0 | 0 | BAAPCD Engineering Estimate | Possible conflict with the proposed oxidant control strategy. Requires closer examination. |
| 5. | Adopt lower particulate loading - 0.1 to 0.05 gr/SCFM. | Primarily a change from any cyclone control to BAG House or Electrostatic Precipitator on 1000's of small operations. | 0 | 0 | BAAPCD Engineering Estimate | Deferred for closer examination in the CPP, this program is directed at controlling particulates. |
| 6. | Lower process weight allowance scale. | Less than 100 sources (e.g., Catalytic Crackers, Fluid Coking, Kilns and Fertilizer Plants) affected. | 0 | 0 | BAAPCD Engineering Estimate | Deferred for closer examination in the CPP, this program is directed at controlling particulates. |
| 7. | Lower process weight maximum. | Less than 100 sources (e.g., Catalytic Crackers, Fluid Coking, Kilns and Fertilizer Plants) affected. | 0 | 0 | BAAPCD Engineering Estimate | Deferred for closer examination in the CPP, this program is directed at controlling particulates. |
| 8. | Options 14-18 (Table 9) are all forms of BACT. | Best Available Technology with minor variations. | Very Significant | | BAAPCD Engineering Estimate | Included in the AQMP (See Specific Proposals and Control Categories covered). |

Table 14 (con't.) Options Considered But Not Included in the Plan (Stationary Sources)

| | RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|---|
| 9. | Options 19-27 are all forms of New Source Review. | Review of new or modified sources; many variations as described. | Significant | | BAAPCD Engineering Estimate | Included in the AQMP (See Discussion in Chapter 7). |
| 10. | Institute a comprehensive program to reduce energy use. | Efficient building heating and air conditioning, reduction of illumination & display lighting - promote heat recovery. | Not Significant | | BAAPCD Engineering Estimate | Will reduce emissions but would be primarily fuel conservation measures; it is not significant as an organic control. |
| 11. | Plant operation scheduling - (many options as described in Table 9). | Seasonal (day, week, month) scheduling including close attention to interruptable operations & staggering operations on 7 vs. 5 day/week. | Not Significant | | BAAPCD Engineering Estimate | Generally difficult due to social-economic factors and not a factor in reducing organic emissions. Does not conform with Federal and State approach of continuous, positive emission reduction program. |
| 12. | Air monitoring combined with meteorological analysis. | Approach relies on accurately predicting problems and implementing needed controls. | Not Significant | | BAAPCD Engineering Estimate | Isolates air pollution problems--not significant in organic emission control. Again, is not a continuous, positive emission reduction program. |
| 13. | Adopt particulate regulation based on particle size. | Self explanatory. | 0 | 0 | BAAPCD Engineering Estimate | No effect on organic emissions (particulate control proposal). |
| 14. | Replace throw-away container with re-usable containers. | Self explanatory. | 0 | 0 | BAAPCD Engineering Estimate | No appreciable effect on organic emissions. |
| 15. | Burn Solid Waste near point of generation to reduce long hauls. | Self explanatory. | Not Significant | | BAAPCD Engineering Estimate | Not a significant source of organic emissions; low potential benefits. |
| 16. | Apply 1309. with modified trade-off of 134 & 1311.2. | New Source Review with clearly defined variations. | Significant | | BAAPCD Engineering Estimate | NSR Rule included in AQMP. |

Table 14. (con't.) Options Considered But Not Included in the Plan (Stationary Sources)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| 17. Require some sort of retrofitting on older plants. | Applies BACT to newer plants plus retrofit of existing plants on a time schedule. | Significant | | BAAPCD Engineering Estimate | Included in AQMP as NSR and BACT. Reducing emissions in this manner and permit additional growth in region. |
| 18. Penalty charge or tax based on amount of emission to encourage reductions. | Emission charge for contaminants to effect industrial control changes to BACT. | Not Significant | | BAAPCD Engineering Estimate | Open to charge that large companies can buy emission allowance. |
| 19. Lowering the Reid Vapor Press of gasoline to reduce hydrocarbon emissions from storage & handling vehicle. | Affects ~ 4 million vehicles, 6000 service stations, 60 bulk plants and all refineries & some chemical plants. | 30 | 35 | BAAPCD Engineering Estimate | An ongoing American Petroleum Institute study indicates that this option is not viable. When formal report is available, this option should be reexamined. |

Table 15. Options Considered But Not Included in the Plan (Mobile Sources)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
| --- | --- | --- | --- | --- | --- |
| o Implement an evaporative emissions retrofit program for all vehicles, and/or recommend catalytic retrofit program for post '71 vehicles able to operate on unleaded gasoline. | Retrofit programs consist of the addition of a new item, or the modification or removal of an existing item of equipment on a vehicle after its initial manufacture.<br><br>In the Bay Area all non-exempt vehicles undergoing change-of-ownership or initial registration require the installation of:<br><br>(1) An $NO_x$ control device for '66-'70 models.<br>(2) An exhaust emission control device for '55-'65 models.<br>(3) A crankcase emission control device for '55-'62 models.<br><br>There have been no further developments of any retrofit programs to date.<br><br><u>Type of Retrofit Program</u><br><br>Evaporative<br>Catalyst | <br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>∿ 4<br>∿ 6 | <br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>Not Applicable | Reductions from evaporative retrofit programs assume that a 25% reduction can be attained from pre-1980 vehicles. Reductions from catalyst programs assume 50% reduction can be attained by retrofitting non-catalyst vehicles. There would be no benefits by 2000 because the affected vehicles will have been retired. | Retrofit programs become less effective as old pre-controlled cars are retired. Thus, this is a short term measure. By 1975 the pre-catalyst vehicles (1971-1975) and pre-2gm/test vehicle (i.e., pre-1980) will only represent about 2% and 20%, respectively, of the total vehicle miles travelled. Since these percentages decrease rapidly thereafter the high cost and the short term benefit of this program does not appear to warrant it. |
| o More stringent certification of compliance procedures. | New vehicles from each engine family are randomly selected from the manufacturers and tested for their emission characteristics by the CARB. More rigorous certification testing procedures could be employed to reduce maintenance requirements of engine components which influence emissions or, where possible, eliminate this maintenance completely. More stringent warranty conditions on emission control systems could also be utilized. | - | - | The air quality benefits could be assumed to be the same as those reductions shown for the motor vehicle inspection program in 2000. This measure could not be feasibly implemented by 1985. | This measure could eventually replace the need for a Motor Vehicle Inspection Program (MVIP). The new technology that would be required to satisfy this control measure would take years to develop. Since this time framais not known, it was decided to keep MVIP through the year 2000. |

Table 15. (con't.) Options Considered But Not Included in the Plan (Mobile Sources)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| (Continuation of previous Recommendation) | CARB has recently adopted regulations in certification test procedures for 1980 and later model vehicles that will require manufacturers of vehicles to make carburetors almost tamper-proof. This measure would recommend more stringent certification requirements which would promote changes in vehicle designs to minimize the need for maintenance and the possibility of tampering. | | | | |
| o Adopt a more comprehensive new motor vehicle surveillance program. | Currently, all production vehicles are checked at the end of the assembly line to ensure that the emission control systems are properly installed and functional. The manufacturer also tests 2% of all vehicles using prescribed Federal test procedures. ARB staff periodically examine the manufacturers' quality control facilities. In addition, all new vehicles at dealerships and preparation centers are spot-checked.<br><br>Title 13 of the California Administrative Code gives ARB the power to implement standards for engine setting tolerances, idle emissions and inspections of control systems to which new and used vehicles must conform as a condition of sale.<br><br>Cross-check testing could be randomly performed on production vehicles currently being tested by the manufacturers. Dealership inspections could be ex- | 0 | 0 | The benefits of this program are assumed to be achieved by the proposed Motor Vehicle Inspection Program (MVIP). | Since all newly acquired vehicles must be registered with the Department of Motor Vehicles, these vehicles could be required to satisfy MVIP requirements before such registration. Thus, it is assumed that the MVIP would eliminate the need to step-up this existing program. |

Table 15. (con't.) Options Considered But Not Included in the Plan (Mobile Sources)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| (Continuation of previous Recommendation) | panded to include used as well as new vehicles to deter maladjustments being made to maximize vehicle performance. | | | | |
| o More stringent evaporative emission controls. | Evaporative emissions from the fuel system are produced by two effects, (1) daily ambient atmospheric temperature variations and (2) higher fuel temperature after vehicle usage.<br><br>Since 1970, gasoline evaporative emission control systems have been installed on all new cars sold in California to reduce emissions from the carburetor and fuel tank. Control of heavy duty vehicles begin with 1983 model year.<br><br>More stringent evaporative emission standards have been adopted for 1980 and subsequent model year vehicles. A new certification test procedure will also be used beginning in 1978. | 0 | 0 | The 1980 standards are already close to vehicle background levels. Thus further reduction would result in not appreciable benefits. | Stabilized background evaporative emissions, from painted or greased surfaces or vinyl upholstery, are thought to represent 40-50% of the 2 grams per test standard promulgated for post-1980 vehicles. Thus, further reduction would not be significant. |
| o Promote use of new or modified fuels. | The modification of fuels has been and continues to be investigated in an effort to come up with an efficient nonpolluting fuel. Much experimentation has also been done on the use of alternative fuels such as methanol, hydrogen, and other types of fuels. | - | - | Not Applicable | Since new technological developments in emission control is a result of more stringent emission standards, this measure may be a result of the proposed control measure to reduce emission standards by 50%. Thus the effect would be comparable. |

Table 15. (con't.) Options Considered But Not Included in the Plan (Mobile Sources)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| o Promote use of alternative power sources. | The development of non-polluting power sources has progressed rapidly over the last 5-10 years. Unfortunately there has not been a strong push for mass producing any of these engine types. | – | – | Not Applicable. | Same rationale as for "new or modified fuels." |
| o Emission standards for other mobile sources. | This would include the adoption of emissions standards for mobile sources such as construction equipment, locomotives, ships, or recreational vehicles. | – | – | | Emissions from off-highway mobile sources for 1985 are 50.3 t/d for HC, 73.7 t/d for $NO_x$ and 322.6 t/d for CO, and for 2000 75.4 t/d, 94 t/d and 389.3 t/d, respectively. Staff believes that these sources may be controllable, but there does not seem to be any available information as to the extent of this control. Thus this measure was dropped at this time due to lack of adequate information, but should be looked at in future updates of the plan. |

Table 16. Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|

## I. MEASURES TO IMPROVE TRAFFIC OPERATIONS

### A. IMPROVE TRAFFIC FLOW

This general class of controls is designed to improve air quality by smoothing the flow of traffic. Since certain emissions increase due to "stop and go" traffic conditions, smoothing traffic flow would help reduce overall emissions. Traffic flow improvements are particularly suited to alleviating carbon monoxide problems. However, because of increasingly stringent motor vehicle emission standards for new cars, CO is not expected to be a long-term regional problem in the Bay Area, although local "hot-spots" may surface. These can be dealt with on an individual basis.

| RECOMMENDATION | DESCRIPTION | 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Computerized Traffic Control | Traffic flow would be improved through a system of computerized traffic signals on selected arterial streets. | Negligible | - | Emissions vs. Speed Curves | This measure was dropped early in the analysis because only very small reductions in oxidant precursors would be achieved through speed improvements, especially considering the small portion of regional traffic that would be affected. Also, the improved flow might induce additional travel, which would offset any gains in air quality. A quantitative assessment was not conducted. |

Table 16. (con't.) Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Traffic Engineering Improvements | Traffic flow can be improved by a number of small projects which would redesign intersections or small street segments. However, if overall capacity were increased, and more trips generated, there could be a negative air quality effect. | Negligible | - | Emissions vs. Speed Curves | This measure was dropped in the first screening because it would affect only a small portion of travel, and any air quality effects would likely be insignificant. A quantitative analysis was not conducted. |
| Off-Street Freight Loading | Zoning regulations would specify off-street freight handling, which would improve traffic flow and hence air quality. | Negligible | - | Emissions vs. Speed Curves | The improved flow would have very little effect on oxidant precursors. Thus this measure was dropped in the initial screening without qualification. |

B. REDUCE PEAK PERIOD TRAFFIC VOLUMES

Much of the peak oxidant problem can be traced to emissions generated during the morning hours. This is due to the time required for photochemical reactions to take place. Any reduction or spreading of these early morning emissions could possibly reduce the intensity or shift the location of peak oxidant concentrations. However, current knowledge of oxidant formation indicates that a very large shift in time would be required and moreover the measures in this category would be difficult to implement to the degree necessary to have this significant effect.

| RECOMMENDATION | DESCRIPTION | 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| 1. Staggered Work Hours | This program would shift the daily work schedule so that all employees would not arrive and leave at the same time. This could take the form of "staggered hours," where subgroups of a total work force operate on a fixed schedule, or "flex-time," where employees are given the option of determining their own hours within certain limits. This measure could improve air quality by a) reducing congestion, b) spreading early morning emissions, and c) providing employees with an opportunity to adjust their schedules to accommodate other modes of travel. | Negligible | - | Previous studies and MTC staff judgement | This measure was eliminated at the initial screening because it would redistribute auto trips, rather than eliminate them. Although the air quality benefits would be slight, it may be desirable to implement this strategy for other reasons, such as reduction in congestion. |

Table 16. (con't.) Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Four Day Work Week | The standard work week would be shortened to four days, with the work day lengthened and/or the weekly hours worked shortened. One-fifth of the commute travel could be eliminated, but the additonal leisure time would probably generate other recreational or shopping trips. | Negligible | - | Previous studies and MTC staff judgement | Because of the potential for additional trips, it was felt that this measure would have only a small effect on air quality, and it was therefore eliminated during the initial screening. |
| Off-Peak Freight Delivery | Freight deliveries would be prohibited during peak periods. This would both reduce peak period traffic and also improve traffic flow by removing the slower vehicles and the trucks stopped while loading. | Negligible | - | Previous studies and MTC staff judgement | Only a small percentage of regional travel would be affected by this measure, and so any air quality improvement would be virtually undetectable. This measure was therefore dropped from further consideration during the initial screening. |

II. MEASURES TO REDUCE VEHICLE USE

A. MEASURES TO RESTRICT VEHICLE OWNERSHIP

This strategy is designed to reduce travel by limiting the number of vehicles.

| RECOMMENDATION | DESCRIPTION | 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Additional License Fee. | This measure could take a number of forms. It could be a tax increase on all cars, or one which would put a progressively heavier tax on the more polluting cars. Another alternative would be to tax second or third cars in a household and so reduce mobility. | Negligible | - | Previous studies and MTC Staff judgement | Although this measure is appealing from an implementation standpoint, at least one study* has indicated that an annual fee would not be a significant factor in a decision to own or drive a car, unless the fee was extremely high. This measure was thus dropped in the initial screening.<br><br>*R.H. Pratt Associates, Inc., "Transportation Controls for Air Quality Improvements in the National Capitol Region," October 1976. |

Table 16. (con't.) Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Registration Limits. | Instead of taxing vehicles with higher pollution potential, this measure would set limits on the numbers of such vehicles which could be registered. The EPA promulgated TCP proposed a ceiling on motorcycle registrations, but this measure was dropped in final version. | Negligible | | Previous studies and MTC Staff judgement | The implementation and equity problems of this measure are formidable. Because of this, the program could not be set up at a scale which would have a significant effect on air quality. This measure was eliminated during the initial screening. |
| | B. MANAGEMENT OF AUTO ACCESS<br><br>This strategy would discourage auto use by restricting the areas where autos can travel or park. | | | | |
| Better Enforcement of Parking Regulations. | There are many current parking regulations which, if enforced, could discourage certain auto trips. Notable among these are the restrictions on long-term parking which could persuade some commuters to take transit. Other actions, such as enforcement of truck loading zones, could result in a smoother flow of traffic. | Negligible | | MTC staff judgment | Because staff believed that the current number of violators was relatively low, the resultant effect in air quality would be small. However, this measure could be effective in jurisdictions where enforcement is currently lax. The measure was eliminated during the initial screening. |
| Limit Number of Parking Spaces. | The intent of this measure is to reduce the available parking and so limit the number of autos which can effectively use the controlled area. There are two implementation options: (a) limit the construction of new parking facilities, and (b) cut back the number of parking spaces already available. | ~ 0.4 | * | Travel Model Analysis | The effect of freezing parking in the CBD's was investigated. Although this measure is effective, it was not included because of the potential for inequity between the large downtown areas and the smaller cities. However, it does remain a possible option. |
| Prohibit On-Street Parking During Peak Hours. | This measure is designed to improve air quality primarily by improving the flow of traffic. It also serves to discourage certain trips since it limits the available parking. | Negligible | | MTC staff judgment | This measure was not pursued since it is currently practiced by the major cities in their CBD's. |

Table 16. (con't.) Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Area License | A special license would be required to bring a car into certain designated areas. This would encourage a shift to other modes. | Variable | | Previous studies and MTC staff judgement | In the past few years there has been increased interest throughout the world in the possibility of imposing user charges to discourage automobile travel in major urban areas. Singapore instituted a program which has been successful but no cities in Europe or North America have tried this concept. A similar type of program was under discussion in Berkeley but was not pursued. Although congestion pricing would certainly be effective in reducing auto-related emissions, this measure was eliminated during the initial screening because of equity problems, implementation problems and public acceptability. It was felt that a similar effect could be obtained, at least in the CBD's, by increasing long-term parking rates. |
| Auto Free Zones | This measure involves the designation of areas within a city (e.g., CBD's where vehicles are prohibited, with the exception of buses, taxis, and emergency vehicles). This technique can result in an improved pedestrian environment and would encourage people to use transit for the entire trip. To develop traffic, necessary freight movements, improved transit access, and, in some cases, parking structures on the fringes. This concept has proved successful in a number of cities, most in Europe. In the U.S., the major examples of such zones have been shopping malls. | ∿ 0.1 | * | Travel Model Analysis | An area within the San Francisco CBD was analyzed as a potential auto control zone. This roughly corresponds, to the area recommended in the revisions to the Transportation Element of the San Francisco General plan.* This measure was recommended in the draft AQMP. During the public review of the plan, this measure was deleted and recommended for further study. The City of San Francisco is initiating such a study in July, 1978.<br><br>*Adopted by the San Francisco City Planning Commission. Resolution No. 7657, January 20, 1977. |

Table 16. (con't.) Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Gas Rationing | This is generally considered the "ultimate" measure. The supply of gasoline is limited in an effort to cut travel and thus pollutant emissions. This measure would have significant administrative problems. | Variable | | Joint Technical Staff estimate | This measure was not considered for inclusion in the draft AQMP because of the significant administrative problems and public acceptance problems which would surface. Overall <u>fuel</u> rationing has been suggested as an alternative to gas rationing in an effort to spread the burden over all segments of the economy. It should be noted that since autos will constitute only 15% of regional hydrocarbon emissions in 1985, a 20 percent cutback in gasoline availability would reduce regional hydrocarbon emissions by approximately 23 tons. |

### C. MEASURES TO INCREASE COST OF AUTO USE

Another way of discouraging auto use is to increase the cost of auto commuting relative to transit or carpooling. However, it generally takes a fairly large increase to effect a significant shift to transit. The more effective pricing strategies are those which serve as daily visible reminders of the real costs of auto commuting.

Table 16. (con't.) Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Road Pricing Techniques | This measure could be implemented in two distinct ways. In one, a fee would be charged for the use of certain roads. This is similar to a toll, except that it is more widespread and would likely not be collected at a tollbooth. Instead, some system of in-car meters or electronic scanning devices might be used as automatic billing devices. The second form is a congestion toll, where the rates would increase with the level of congestion. | Negligible | | Previous studies and MTC staff judgement | These measures have not yet been tried as air quality strategies. The technology is not readily available for the first and the second is still fairly new and untested. For this reason, and because of problems in public acceptability, this measure was dropped in the initial screening. The discussion included under measure B(4) is also applicable to this measure. |
| Increased Parking Costs | The purpose of this measure would be to discourage auto use by increasing the overall commute cost via additional parking charges. A special parking tax of 35 percent, to be levied on all vehicles parking between 6 and 10 am.m, has been proposed. | ~ 0.3 | * | Travel Model Analysis | The 6-9 a.m. period was selected to minimize the additional burden on those driving for non-work purposes. This measure was recommended in the draft AQMP. During the public hearings and plan review process, however, this measure was deleted. A major concern expressed was its questionable effectiveness and the competitive advantage of those lots not imposing the parking tax. |
| Minimum Parking Fee at Large Shopping Center | Most of the measures that were considered focused on the work trip. Other trips, such as shopping, are important in the formation of air pollution but are not as susceptible to diversion to transit. However, many of these trips are made to purchase only one or two items. If the shopper were to consolidate these single trips | See Description and Comments | | | Staff was unable to quantify the effectiveness of this measure because of the lack of experience with this type of action. However, we estimate that shopping trips in 1985 will generate 53 tons of HC, 826 tons of CO, and 39 tons of NOx daily. This is significant, and therefore this measure was recommended. |

Table 16. (con't.) Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| (Continuation of previous Recommendation) | into one or two weekly trips, the air quality effect could be important. To encourage this consolidation of trips, a minimum 50¢ parking fee at shopping centers that maintain over 500 parking spaces was proposed. | | | | |
| Eliminate Free Employee Parking | Employers located outside the CBD's virtually always provide their employees with free parking. To encourage these employees to shift to transit or carpools, this measure specifies a $1.00 parking fee be levied at all employee lots of 500 or more spaces. | ~ 0.9 | * | Travel Model Analysis | Although these reductions are relatively high, it was felt that the current lack of transit access to many industrial areas would be a hardship. Therefore, this measure is not recommended at this time. |
| Additional Gasoline Tax | The gas tax would be raised to reduce the demand for vehicular travel. The extra revenue would be used to finance transit improvements or other non-auto alternatives. Unfortunately, the energy crisis of 1974 demonstrated that, even with a rather large increase in cost, the use of autos did not decrease significantly. This experience showed that a 10% increase in pump price facing the consumer would cut the demand probably 1.5%. In the long run, the application of this measure would probably produce a shift toward smaller, more fuel-efficient cars. The imposition of this measure raises questions of equity, since the poor and those not having access to transit would be penalized most severely. | < 0.1 | — | Travel Model Analysis | A 15¢/gal increase in the gas tax would reduce HC emissions in 1985 by less than 0.1 ton/day. The CO reduction was 0.8 tons/day with NOx reduced less than 0.1 ton/day. This measure was eliminated during the secondary screening. |

Table 16. (con't.) Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Increased Tolls. | Bridge tolls would be increased to reduce the volume of autos using the facility and to generate revenue which could be used to finance improvements in the transit system. MTC was recently given authority over the level and use of tolls on the trans-bay bridges. Tolls on the Bay, San Mateo, and Dumbarton bridges were recently raised to 75¢. The Golden Gate Bridge District has just adopted a $1.00 toll. | ~ 0.2 | * | Travel Model Analysis | A peak toll of $1.25, with an off-peak toll of $1.00, would reduce HC by 0.2 tons/day, CO by 3.1, and $NO_x$ by 0.2 (1985 emissions). In addition, over $12 million additional revenues would be generated annually, which could be used for transit improvements. This measure was recommended in the draft AQMP. During the public hearings and plan review process, however, this measure was deleted. A major factor in deleting the measure was the inequity of its impacts. |
| "Smog Charges." | This measure would assess an additional charge on the auto driver for the pollution generated by the automobile, thus encouraging a shift to other forms of transport or to less polluting cars. The implementation could be done through some of the measures already mentioned, such as the gas tax or registration fee, possibly accompanied by some rebate scheme for those autos with superior emissions control equipment. | Negligible | | MTC staff judgment | The effectiveness of this measure was judged to be similar to that estimated for the additional gas tax. An extremely high charge was thought necessary to effect significant reductions in auto use - the measure was therefore eliminated during the secondary screening. |
| | D. MEASURES TO REDUCE THE NEED TO TRAVEL<br><br>This strategy is designed to maximize or eliminate unnecessary travel. Unfortunately, the effectiveness and feasibility of these types of measures are uncertain. | | | | |

Table 16. (con't.) Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Communications Substitutes. | Certain trips could be eliminated by using other means of communication. This could include business trips as well as shopping trips. The technology for visual communications is becoming more available. However, the extent to which the public will adapt to these new systems is uncertain. The rapid growth in electronic communications in the past decade has not reduced the need to travel. | Uncertain, probably negligible | | See comments | This measure was eliminated in the initial screening because its proven effectiveness in the near term is doubtful. |
| Goods Movement Consolidation. | This measure would reduce truck travel by consolidating freight deliveries. Basically, the concept is to have one terminal where the freight is delivered and sorted, and then small trucks would complete the delivery. The measure would thus decrease truck VMT and probably also reduce auto emissions as well by permitting a smoother traffic flow. | Negligible | | MTC staff judgement | The effectiveness of this measure would be minimal because of the small percentage of travel that would be affected. The measure was thus dropped in the initial screening. |

## III. MEASURES TO ENCOURAGE ALTERNATIVE MODES OF TRAVEL

### A. INCREASE TRANSIT RIDERSHIP

This set of measures would provide incentives for transit as an alternative transportation mode. For many commuters transit is a viable option, yet additional incentives need to be provided to induce significant diversion from the automobile. The following measures are designed to promote the transit mode.

Table 16. (con't.) Options Considered But Not Included in the Plan (Transportation Controls)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| Fare Reductions | There are a number of variations of this measure. One is to simply reduce or eliminate transit fares. This would probably not be very effective, since the fares throughout the Bay Area are already relatively low. A second option is some form of a monthly pass. This has good potential since it would eliminate the psychological impediment of repeated payments, and so would encourage the diversion of casual trips to transit. A related option is the coordination of transfers between systems. | Negligible | | Previous Studies and MTC staff | Because of the current low fare level, further reductions could conflict with regional policy and potentially state law. The monthly pass would probably not have significant air quality effects, but may be a desirable mechanism for encouraging transit ridership. |
| Improved Transit Comfort | This measure seeks to reduce the differences between the auto and transit modes by improving the comfort of transit service. This would be done by providing shelters at bus stops, better security, more comfortable buses, or other amenities. | Negligible | | MTC staff judgement | It is believed that improved amenities alone would not signficantly influence transit demand. Moreover, most of the existing transit development programs in the Bay Area will involve new, comfortable buses, additional bus shelters and radio communication. Thus, this measure was dropped from consideration in the initial screening. |

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATE | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| | **B. ENCOURAGE THE PEDESTRIAN MODE** | | | | |
| Provide Pedestrian Amenities | For short trips, walking is frequently the best alternative. Providing amenities such as wider pavements, or moving sidewalks between major activity centers can encourage people to walk for short trips. | Negligible | | Previous Studies and MTC staff judgement | A survey of previous studies indicated that, with the exception of auto-free zones, the provision of these amenities would not produce a significant shift from the auto. Rather, it is the dense land use pattern itself which generally encourages pedestrian activity. Since the auto-free zone was already included as a separate measure, we felt that the provision of these other amenities was not warranted from a strict air quality perspective. |
| | **C. MEASURES TO ENCOURAGE RIDE SHARING** | | | | |
| | Carpooling has good potential as a strategy for reducing vehicle travel. It requires no new capital investment since the cars are already available. It can offer many amenities that transit cannot, such as door-to-door service. Finally, the cost savings are easily perceived by the individual riders. | | | | |
| Toll Reduction for Carpools· | One means of encouraging carpools is to reduce or eliminate the tolls on bridges or other toll facilities. Currently, the trans-bay bridges charge no tolls for carpools during peak hours. The Golden Gate Bridge also allows free passage of carpools. | Negligible | | MTC staff judgment | Virtually all bridges now offer free passage to carpools during peak periods. Very little could be done to expand this measure, so it was eliminated during the screening process. |

*The effectiveness of these measures was not estimated separately for the year 2000. They were combined with the compact development strategy for evaluation.

## Table 17. Options Considered But Not Included in the Plan (Development and Land Use Management)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATES | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| General Policy: Alter regionwide development patterns to reduce automobile travel by means of local and regional policies on land use and urban services. | See Specific Policies and Actions below | Not estimated | 24 | ABAG land use and MTC transportation models | The reductions in emissions are based on a total regional population of 5.4 million. If the population were at the higher range projected (6.1 million), the emission reductions shown would be higher, but so would the total from which the reductions would be subtracted. The EMTF deleted the general policy and its policies and actions. |

POLICY A - Extend new development only to those locations with existing sewer and water service or sewer and water service committed in capital improvement programs.

Action 1 - Local Agency Formation Commissions (LAFCOs) adopt city and special district spheres of influence throughout the region as soon as possible.

Action 2 - LAFCOs adopt the "urban service area" concept for defining urban service commitments and projecting urban land needs for 5, 10 and 20 year periods.

Action 3 - LAFCOs approve annexations and formation of cities and special districts consistent with Action 2 findings on urban service commitments and urban land needs.

Action 4 - Counties and cities enact non-urban zoning outside urban service areas.

Action 5 - Counties and cities enact temporary moratoria on urban zoning and subdivisions outside urban service areas pending the enforcement of non-urban zoning in such areas.

POLICY B - Restrict development outside urban service areas in areas of critical environmental concern (environmental resources, hazards or amenities).

Action 6 - Counties and cities enact agricultural zoning or large-lot rural residential zoning (generally one dwelling unit per 40 acre minimum lot size).

Action 7 - Counties and cities initiate, continue or expand programs under the California Land Conservation Act (Williamson Act), the Open Space Easement Act of 1974 and the Z'Berg-Warren-Keene-Collier Forest Taxation Reform Act of 1976 outside urban service areas.

Action 8 - Counties and cities establish programs of public land management including acquisition, purchase/leaseback, purchase/transfer of development rights, etc.) for locations outside urban service areas.

POLICY C - Develop unimproved land within urban service areas where urban services exist or are committed in capital improvement programs.

Action 9 - ABAG, counties, cities and LAFCOs establish "early warning" inter-agency information exchange programs concerning urban service facility plans at the earliest stages of project planning.

Action 10 - ABAG, counties, cities and LAFCOs expedite plan or project reviews where early information on facilities has been provided, under Action 9.

Action 11 - Counties and cities initiate rezoning and permit preference procedures in locations with existing but unused service capacities (with emphasis on water, sewer, transportation and school services).

Table 17. (con't.) Options Considered But Not Included in the Plan (Development and Land Use Management)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATES | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| POLICY D - Complete, as soon as possible, all needed sewer, water or transportation service improvements within adopted urban service areas. | | | | | |
| Action 12 - LAFCOs review all city, county, or special district sewer, water, or transportation service capital improvement programs and report on priority needs within each urban service area. | Action 13 - ABAG review sewer, water and transportation needs within all urban service areas to determine regionwide priorities among such service needs. | | | Action 14 - ABAG favorably review applications for State/ Federal financial assistance from agencies lacking service capacity within urban service areas, where other existing or committed services have been found by the LAFCO to be capable of accommodating additional development. | |
| POLICY E - Improve highway, street, road and transit systems consistent with local actions to stage land development. | | | | | |
| Action 15 - Counties and cities enact planning and zoning regulations to stage land development consistent with the scheduling of urban services (including but not limited to "development sequence zoning", "tiered zoning districts", development timing permits, etc.). | Action 16 - Caltrans, MTC, counties, cities, and special districts plan, program, fund and construct highway, street, road and transit improvements consistent with local action to stage land development. | | | | |
| POLICY F - Increase housing and job opportunities in existing urbanized areas by encouraging public and private rebuilding into compatibly mixed commercial, industrial and residential land uses. | | | | | |
| Action 17 - Counties and cities initiate and/or expand housing conservation programs in existing urbanized areas. | Action 18 - Counties and cities initiate and/or expand commercial and industrial development and redevelopment in existing urbanized areas. | | | Action 19 - Counties, cities, and special districts initiate and/or expand incentives to public and private redevelopment in urbanized areas. Emphasis would be on sewer and water facilities, and extensive transit service improvements, but should also include educational and cultural facilities and public safety service improvements where appropriate. | Action 20 - ABAG, counties and cities analyze possible local revenue reforms to provide adequate financial resources to carry out Action 19. |
| Action 21 - ABAG support State legislation to provide local governments with adequate fiscal resources to carry out Action 19. | Action 22 - ABAG oppose Federal and State legislation that would hamper the ability of local governments to carry out rebuilding programs to increase job and housing opportunities in existing urbanized areas. | | | | |

Table 17. (con't.) Options Considered But Not Included in the Plan (Development and Land Use Management)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATES | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| POLICY G - Encourage "infill" development of bypassed vacant land within urban service areas. | | | | | |
| Action 23 - Counties and cities undertake planning studies to inventory bypassed land, identify development problems, and resolve questions of best potential use. | Action 24 - Counties and cities adopt necessary changes in zoning and permit procedures to facilitate development of bypassed parcels affected by special conditions. | | | Action 25 - Service agencies design sewer, water and transportation systems to improve accessibility and service ability of bypassed vacant land in existing urban communities. | |
| POLICY H - Develop at higher densities within service areas where existing or committed urban service capacities, including transit, can support the higher densities. | | | | | |
| Action 26 - In urban service areas with adequate sewer, water and transit capacities, counties and cities rezone appropriate locations to permit higher densities. | Action 27 - Counties and cities enact ordinances (such as those for planned unit development or cluster zoning) to foster higher densities on appropriate sites. | | | | |
| POLICY I - Limit development of land within urban service areas where soil, slope, or other conditions can support only low-density development. | | | | | |
| Action 28 - Counties, cities and special districts deny primary urban services to these locations by excluding them from capital improvement programs and design of service systems, and by enactment of hookup moratoria, etc. | Action 29 - Counties, cities, and special districts establish programs of public land management (including but not limited to public land acquisition, purchase/transfer of development rights, purchase/leaseback, etc.) to maintain appropriate sites in open uses. | | | | |
| POLICY J - Improve the balance of jobs and housing in jurisdictions throughout the region to reduce the necessity for long distance home-to-job travel. | | | | | |
| Action 30 - Cities and counties adopt programs to increase local employment opportunities if a substantial proportion of their residents work elsewhere. | Action 31 - Cities and counties adopt programs to increase local housing opportunities in a price range suitable for their work forces if a substantial proportion of their work forces live elsewhere. | | | Action 32 - ABAG conduct A-95 and EIR reviews to support local government to improve the balance of jobs and housing in communities throughout the region. | Action 33 - ABAG support State and Federal funding allocations for facilities and programs offering incentives to economic development or housing development in appropriate jurisdictions. |
| POLICY K - Mix residential/commercial and industrial development in communities throughout the bay region. | | | | | |
| Action 34 - Counties and cities revise zoning ordinances to allow compatible mixtures of land uses with adequate design or performance standards (including planned unit developments, performance standard zoning, etc.). | Action 35 - Counties and cities expand application of conditional use permits where appropriate. | | | | |

Table 17. (con't.) Options Considered But Not Included in the Plan (Development and Land Use Management)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATES | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| POLICY L - Discourage new large-scale land development projects that are exclusively commercial, industrial or residential, unless such projects clearly demonstrate that they improve the overall balance of jobs and housing in that city, county, or subregion. | | | | | |
| Action 36 - Counties, cities and LAFCOs deny incorporation or annexation of large-scale development proposals that are exclusively commercial, industrial or residential, unless such incorporation or annexation can be shown to improve the overall balance of jobs and housing in the city, county or subregion. | Action 37 - MTC, the California Department of Transportation and transportation districts deny regional transportation system access or extension to proposed large-scale land development projects that are exclusively commercial, industrial or residential unless such transportation actions can be shown to improve the overall balance of jobs and housing in the city, county or subregion. | | | | |
| POLICY M - Fund new wastewater and transportation facilities only after areas serviced have taken actions to carry out actions of this plan. | | | | | |
| Action 38 - The State Water Resources Control Board and the Environmental Protection Agency require applicants for wastewater facilities under Section 201 of the Federal Water Pollution Control Act to demonstrate, prior to construction funding, that specific actions (including but not limited to land development regulations, urban service commitments, etc.) have been taken by affected jurisdictions to carry out actions of this plan. | Action 39 - The U.S. Department of Transportation, the California Transportation Commission, the California Department of Transportation and the Metropolitan Transportation Commission require applicants for transportation improvement grants to demonstrate prior to funding for acquisition and construction that specific actions (including but not limited to land development regulations, urban service commitments, etc.) have been taken by affected jurisdictions to carry out actions of this plan. | | | | |
| POLICY N - Review development proposals for air quality effects and consistency with compact development recommendations in the plan (indirect source review) | | | | | |
| Action 40 - ABAG, BAAPCD and MTC adopt memoranda of understanding and procedures for prompt and thorough joint review of significant development proposals. Review would be conducted for proposals (such as shopping centers, industrial parks, office complexes, etc.) where significant air pollution could result from the project's generation of auto traffic. | Action 41 - BAAPCD adopt permit procedures for application to indirect sources. | | | Action 42 - ABAG encourage and support local government efforts to determine direct and indirect effects on air quality in making local land use decisions. Such support shall include technical assistance and analysis. | Action 43 - ABAG encourage and support local government efforts to reduce adverse effects of development proposals on air quality, including but not limited to assistance in identifying and implementing mitigation measures for adverse impacts of municipal wastewater facilities and transportation improvement programs. |

Table 17. (con't.) Options Considered But Not Included in the Plan (Development and Land Use Management)

| RECOMMENDATION | DESCRIPTION | EST. HYDROCARBON EMISSION REDUCTIONS (Tons/Day) 1985 | 2000 | BASIS FOR ESTIMATES | COMMENTS AND SCREENING RATIONALE |
|---|---|---|---|---|---|
| POLICY O - Adopt financial programs to support local and regional agency actions and private sector development actions consistent with policies in this chapter to reduce home-to-work distance and auto dependency. | | | | | |
| Action 44 - ABAG, counties and cities support State and Federal legislation to provide subventions and other fiscal assistance to cities and counties carrying out development policies to achieve air quality standards. | Action 45 - ABAG, counties and cities support State and Federal legislation providing tax incentives to the private sector for rebuilding and development within existing urbanized areas. | | | Action 46 - ABAG, counties and cities support State and Federal legislation providing financial support to local and regional agencies for carrying out development management policies and reviews to achieve air quality standards, especially to mitigate adverse impacts on low- and moderate-income households. | |
| POLICY P - Adopt a coordinated regionwide program for carrying out actions for attainment and maintenance of air quality standards through development and land use management actions by cities, counties, special districts, ABAG, BAAPCD, MTC, LAFCOs and other appropriate local and regional agencies. | | | | | |
| Action 47 - ABAG identify, within six months of General Assembly adoption of an initial air quality maintenance plan, which implementing actions are being carried out by local and regional agencies. | Action 48 - ABAG include, in each annual revision of the AQMP, agreements reached among local and regional agencies for carrying out land use and development management actions included in the initial AQMP. | | | Action 49 - ABAG include, in each annual revision of the AQMP, an identification of actions not being carried out by all appropriate agencies, and which actions are to be carried out by appropriate agencies by the next annual revision of the AQMP. | |

# Section-G

# EVALUATION OF ALTERNATIVE TRANSPORTATION CONTROLS

A number of transportation controls were analyzed as part of the air quality planning process. The evaluation of these measures was summarized in an earlier paper, AQMP Technical Memorandum 23, "Evaluation of Transportation Control Measures," November, 1977. This section is intended to describe the analysis of each measure in more detail, report the findings, and document the decision making process, as requested by the Air Resources Board and the Environmental Protection Agency.

The DOT/EPA Transportation/Air Quality Planning Guidelines of June 1978 specify an analysis of the 18 measures outlined in Section 108(f) of the 1977 Clean Air Act Amendments. This section--prepared in December 1978 by MTC--is also intended to satisfy that requirement. However, since MTC's analysis was ongoing at the time the Clean Air Act was amended, the controls were not structured around the 18 measures. Accordingly, documentation is provided for the 33 measures analyzed, and a reference to the 108(f) measures is made.

This section is organized into three parts. The first gives an overview of the methodology and decision process. The second discusses each measure in detail. The last part discusses the Section 108(f) measures and describes these in relation to the controls described in the second part of the section.

MTC adopted (Resolution 619) the analysis reprinted in this section on December 8, 1978.

## WORK TRAVEL EMPHASIS

The Air Quality Maintenance Planning Effort, like its predecessors, has focused particularly upon the journey to work as being the type of travel most susceptible to modal changes. Because of the regularity and repetitiveness of the commute trip and because of the availability of transit alternatives, the journey to work is more susceptible to a diversion to transit or carpooling in the short term. Other types of travel -- such as shopping, doctor appointments, or shuttling children -- tend to be irregular, occur in locations and times when transit service is not competitive, and often require a vehicle for carrying packages and such like. The vast majority of Bay Area residents who have a true choice between transit and the automobile for this type of travel, have and will choose the auto. Staff did not believe it possible to make substantial reductions in non-work auto travel by implementing short-term transportation control measures.

The journey to work constitutes only 30 percent of automobile travel in the Bay Area, the remaining 70 percent is composed of the travel purposes discussed earlier -- shopping, personal business, etc. Of the remaining 30 percent, less than half is destined to major employment centers where transit is currently a viable alternative for most persons.

The emission control program for new automobiles has had a major positive impact in reducing regional pollutant emissions. Analyses indicate that in 1975, for example, auto pollutants constituted 33 percent of regional hydrocarbon emissions; whereas in 1985, despite major increases in auto travel, the proportion of regional emissions attributable to the auto will decline to 15 percent. Therefore the proportion of regional hydrocarbon emissions attributable to commute travel is approximately 5%. It is clear from the outset that even massive reductions in automobile travel would have only a minor impact on pollutant emissions.

This is a fundamental finding with respect to transportation controls for oxidant reduction -- an initial evaluation demonstrates that the effectiveness will be small.

## TYPE OF EMISSIONS

Another aspect of the analysis which influences the choice and effectiveness of transportation controls is the relative proportion of running emissions for light duty vehicles. As the Motor Vehicle Control Program is gradually implemented, the "cold-start" and "hot-soak" become an increasingly larger proportion of the emissions as shown in Table 18. This phenomenon has a significant impact on the choice of controls: eliminating automobile trips, rather than simply reducing vehicle-miles-traveled becomes more important.

Table 18. Hydrocarbon Emissions from Light Duty Vehicles

| Year | Emissions (tons/day) | | Percent (of LDV Emissions) | |
|---|---|---|---|---|
| | Trip-End | Link | Trip-End | Link |
| 1975 | 206 | 172 | 54 | 46 |
| 1985 | 99 | 35 | 74 | 26 |
| 2000 | 128 | 49 | 72 | 28 |

METHODOLOGY

Initially, a comprehensive listing of potential control measures, which could conceivably reduce emissions in the short-term was assembled. Table 19 represents a compilation of measures developed from a review of earlier reports conducted here and elsewhere: the original Transportation Control Plan (TCP) promulgated by EPA in 1973[1], the substitute TCP proposed by the Metropolitan Transportation Commission[2], and the Regional Transportation Plan[3].

Having assembled this initial list, a three stage evaluation process was used to successively narrow the potential controls to a manageable number for policy-level evaluation.

(1) Staff & Technical Advisory Committee Review

A literature search was done to assess the knowledge gained previously on each control measure. Using this data, workshops were held with the Joint Technical Staff and the AQMP Technical Advisory Committee for the purpose of screening out those measures which did not warrent further study. The primary criterion at this stage was the emissions reduction effectiveness. However, those measures which would generate extreme social or economic problems were also eliminated.

(2) Quantitative Evaluation

The remaining measures were then analysed quantitatively. The mode-split model in the transportation modelling system was used to estimate the changes in travel behavior which might result from changes in parking

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1 Environmental Protection Agency, "California Transportation Control Plan," Federal Register, November 12, 1973.

2 Metropolitan Transportation Commission, "Proposed Transportation Control Plan for the San Francisco Bay Area Air Quality Control Region," March 1975.

3 Metropolitan Transportation Commission, "Regional Transportation Plan," issued in 1973 and updated annually.

Table 19: Candidate AQMP Transportation Strategies

I. MEASURES TO IMPROVE TRAFFIC OPERATIONS

A. Improve Traffic Flow

1. Computerized traffic control
2. Ramp metering
3. Traffic engineering improvements
4. Truck regulations

B. Reduce Peak-period Traffic Volumes

1. Staggered work hours
2. Four day work week

II. MEASURES TO REDUCE VEHICLE USE

A. Restrict Vehicle Ownership

1. Additional license fee
2. Registration limits

B. Management of Auto Access

1. Better enforcement of parking regulations
2. Limit on number of parking spaces
3. On-street parking prohibited during peak hours
4. Area license
5. Auto-free zones
6. Gas rationing

C. Increase Cost of Auto Use

1. Road pricing
2. Increased parking costs
3. Parking fee for shoppers
4. Eliminate free employee parking
5. Increased gas tax
6. Increased tolls
7. "Smog charges"

D. Reduce the Need to Travel

1. Communications substitutes
2. Goods movement consolidation

III. MEASURES TO ENCOURAGE ALTERNATIVE MODE OF TRAVEL

A. Increase Transit Ridership

1. Additional transit service
2. Fare reductions
3. Improved comfort
4. Bus and carpool lanes

B. Encourage Pedestrian Mode

C. Encourage Bicycle Mode

D. Encourage Ride Sharing

1. Toll reduction for carpools
2. Preferential parking for carpools
3. Carpool matching information
4. Assist vanpool formation

costs, travel time, and other variables[4]. These changes were then applied to the baseline emissions to estimate the potential reductions.

On the basis of this information, staff recommended a set of controls for consideration by the policy bodies. The strategy involved a balance of incentives and disincentives, with revenue-generating measures to finance improvements.

Since the Air Quality Maintenance planning effort is intended to meet air quality standards "as expeditiously as practicable", only measures which had a high probability of implementation before 1985 were recommended. Throughout the screening process, several evaluation criteria were considered:

1) Emissions reduction effectiveness
2) Cost
3) Institutional structure
4) Ease of implementation
5) Public acceptance
6) Legal requirements

(3) Policy Level Review

The set of control measures proposed by staff, and contained in the December 1977 draft AQMP were reviewed by the EMTF, the ABAG Executive Board, the ABAG General Assembly and the MTC. It should be noted that under the terms of the Memorandum of Understanding between ABAG, BAAQMD and MTC, final authority for the adoption of transportation controls rested with the MTC. The elected officials involved in the plan preparation were cognizant that a wide range of controls had been considered and narrowed to a manageable proposal. All of the controls considered, but rejected by staff and advisory committees, were described in abbreviated form in a separate section of the draft plan[5]. Controls were removed from this list for more detailed discussion upon request.

Several public hearings on the draft plan were held, and ABAG and MTC staffs presented and discussed the proposals with business, civic and environmental groups. There was no overwhelming request to strengthen the draft plan with more stringent controls. On the contrary it appeared to be the consensus of policy makers that measures which would induce severe hardship or lifestyle changes should not be included in the proposed plan.

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4 Barton-Aschman Associates, Inc., "Sensitivity Analysis of Selected Transportation Control Measures: Potential Reductions in Regional Vehicle Miles of Travel," Memos to Hanna Kollo, MTC on July 22 and August 12, 1977.

5 Association of Bay Area Governments, Bay Area Air Pollution Control District, and the Metropolitan Transportation Comission, Draft Air Quality Maintenance Plan, December, 1977.

Table 20 contains the list of meetings/hearings in which the transportation controls were reviewed.

The MTC, in an attempt to balance the sometimes conflicting goals of air quality and mobility, adopted the following guidelines:

1. MTC will use its funding and project approval power to support compliance with the final land use plan as adopted by ABAG and included in the AQMP.

2. MTC will continue to make air quality a major consideration in project funding decisions.

3. Because the impact of specific pricing control measures appears quite small, MTC will consider such control measures only under certain conditions:

   a. When problems of social and economic inequities in the transportation system are minimized and adequate transportation alternatives exist.

   b. When such pricing measures are necessary to insure that the entire transportation plan is feasible.

   c. When such a measure is evaluated in detail and subjected to full-scale public hearings.

4. MTC policy supports measures which improve or enhance alternatives to the automobile without penalizing those dependent on the auto. These alternatives include transit, carpooling and bicycle systems.

5. Existing MTC policy supports the concept of high occupancy vehicle lanes when they are found to be advisable on a project and location specific basis.

6. MTC, in applying these guidelines and in developing additional transportation measures to improve air quality, will undertake adequate analysis and provide for public review to assure that any proposal will achieve air quality objectives while remaining consistent with other RTP objectives.

7. MTC recommends a strategy of high density residential or commercial zoning around all BART stations and around all major fixed-point transportation centers, where it would improve use of public transit without causing other major environmental problems. This proposal would support better utilization of the regional transportation systems.

Table 20. List of Meetings And Public Hearings
For The Review Of Transportation Controls

- Joint Technical Staff (JTS) Meeting of 12/15/76
  - transportation controls introduced
- JTS Workshop on 1/19/77
  - transportation controls reviewed
- AQMP Technical Advisory Committee Meeting of 3/17/77
  - discussion of candidate control measures
- Environmental Management Task Force (EMTF) Meeting of 6/8/77
  - candidate transportation controls introduced
- EMTF Meeting of 8/31/77
  - results of second screening of transportation controls presented
- EMTF Meeting of 9/14/77
  - staff recommendations for draft Environmental Management Plan
- MTC Meeting of 9/20/77
  - briefing on transportation controls
- EMTF Meeting of 10/12/77
  - further discussion of control measures
- MTC Work Program & Plan Revision Committee Meeting of 10/14/77
  - preliminary findings on transportation controls presented
- MTC Work Program/Plan Revision Commitee Meeting of 11/2/77
  - workshop on transportation controls held
- EMTF Meeting of 12/14/77
  - draft EMP released
- EMTF and ABAG Executive Board Public Hearing of 1/11/78
  - draft EMP
- EMTF Public Hearing of 1/25/78
  - draft EMP
- EMTF Public Hearing of 2/1/78
  - draft EMP
- MTC Work Program and Plan Revision Committee Meeting of 2/3/78
  - Committee made recommendations on transportation controls
- ABAG General Assembly Meeting of 2/8/78
  - review of draft EMP
- EMTF and ABAG Executive Board Public Hearing of 2/16/78
  - draft EMP

- EMTF Meeting of 2/22/78
  - discussion of air quality controls
- MTC Meeting of 2/22/78
  - transportation controls adopted
- EMTF Meeting of 3/8/78
  - discussion and partial action on air quality plan
- EMTF Meeting of 3/16/78
  - adoption of air quality plan
- ABAG Executive Board Meeting of 4/20/78
  - adoption of the EMP
- ABAG General Assembly Meeting of 6/10/78
  - adoption of the EMP

# ASSESSMENT OF CONTROL MEASURES

The next part describes each of the 34 measures, andpresents the results of that evaluation.

1. COMPUTERIZED TRAFFIC FLOW

Description

Traffic flow would be improved through computerized traffic signals on selected arterial streets. Vehicular emissions are greater at low speeds, particularly for CO, thus improving the traffic flow would reduce overall emissions.

History

A number of cities in the Bay Area have already implemented this system. Its primary purpose is to alleviate congestion, air quality improvement being a secondary benefit.

Literature Search

- (Reference 16) - Computer control can adapt to a wide variation in flow, however, its cost-effectiveness beyond manually-set signals is not proven.
- (Reference 13) - The installation of progressive signalization which increased regional average speed 1% would have a negligible effect on regional air quality. However, Carbon Monoxide "hot spots" could be improved by progressive signalization.
- (Reference 9) - The emission reduction effectiveness of a signalization system was rated low for hydrocarbons and low to moderate for carbon monoxide.

Effectiveness

The emissions reductions effectiveness of this measure was judged to be low based on a literature review and the characteristics of the baseline emissions inventory. The latter showed that the emissions base which this measure might affect would be quite small because: 1) link, as opposed to trip-end, emissions become a smaller portion of the total in future years, and 2) the amount of regional traffic which would be affected is quite small. No quantitative assessment was completed.

Other Impacts

This measure would involve a moderate cost to local jurisdictions. Congestion relief would be an additional benefit.

Status

This measure was dropped in the first review by the Technical Advisory Committee and the Joint Technical Staff on the basis of its low potential for the reduction of hydrocarbon emissions. Because of the new information on the CO problem, this measure will be reconsidered to alleviate localized "hot spots".

## 2. RAMP METERING

### Description

Ramp metering is an operational tool which under appropriate conditions can promote optimum use of a transportation corridor. Its use also tends to improve air quality in two ways: 1) by improving the flow of traffic, and 2) by providing bypass lanes at ramps with queues of traffic thus providing a time saving to those using buses or carpools. However, if congestion on a freeway is eliminated, there is the possibility that. in the absence of any other land use or transportation actions, additional long-distance trips could be generated.

### History

A number of ramp metering projects are in place in the Bay Area, primarily in Santa Clara County. One of these is designed with an High Occupancy Vehicle bypass lane. Systems have been proposed for Routes 17 and 80 in the East Bay. However, there has been some opposition from the inner cities, where it is felt that residents would be penalized for the benefit of the long-distance commuter.

### Literature Search

- (Reference 9) - This San Diego study estimated that preferential ramp metering for high occupancy vehicles would have no effect on VMT or trips and may cause an increase in emissions because of long delays on the ramps.

- (Reference 4) - A ramp control project on I-280 did improve flow and decrease overall delay. However, freeway volumes increased, though indications are that most of these trips were diverted from city streets rather than induced.

### Effectiveness

Potential emission reductions were estimated via the travel model sensitivity analysis. It is difficult to quantify this type of measure with sketch planning techniques. However, an estimate was developed on the basis of a reduction in travel time for buses and carpools, representing a combination of ramp meters, HOV bypass lanes, and exclusive bus/carpool lanes. The effect on travel is estimated to be:

| | CBD Trips (Percent) | | | Non-CBD Trips (Percent) | | |
|---|---|---|---|---|---|---|
| Strategy | Number of Autos | Transit Ridership | Shared-Ride | Number of Autos | Transit Ridership | Shared-Ride |
| 12. Bus Lanes with Ramp Metering | | | | | | |
| --Reduce in-vehicle transit time by 10 percent | -2% | +4% | No effect | No effect | +3% | -3% |
| --Reduce in-vehicle transit time by 20 percent | -3 | +9 | -1% | -1% | +8 | -2 |
| --Reduce in-vehicle transit time by 30 percent | -5 | +16 | -4 | -1 | +9 | No effect |
| 14. Car Pool Lanes with Ramp Metering | | | | | | |
| --Reduce shared-ride highway travel time by 10 percent | -1 | -3 | +6 | No effect | -2 | +3 |
| --Reduce shared-ride highway travel time by 20 percent | -2 | -6 | +12 | -1 | -4 | +4 |
| --Reduce shared-ride highway travel time by 30 percent | -3 | -3 | +17 | -1 | -6 | +12 |

A 10% travel time savings translates to a 1985 air quality benefit of:

| | Emissions Reductions (tons/day) | | |
|---|---|---|---|
| | HC | CO | $NO_x$ |
| Bus lanes with ramp metering | 0.1 | 1.6 | 0.1 |
| Carpool lanes with ramp metering | 0.1 | 0.8 | 0.1 |

Other Impacts

The following impacts are based on a evaluation of bus and carpool lanes and ramp metering. A preliminary estimate is that some form of preferential treatment or other transit alternatives could be considered in existing severely congested freeway segments -- for example:

Route 580 from Route 24 to the Bay Bridge
Route 80 from San Pablo Dam Road to the Bay Bridge
Route 101 from the San Francisco airport to the Route 280 diamond lanes

- Costs

Capital costs: Route 580 - $17 million
Route 80 - $106 million
Route 101 - not estimated

- Economic Impacts - Construction jobs would be created, but no significant economic impacts would result from the operation of these systems.

- Energy Impacts - Approximate daily savings of gasoline in 1985 assuming a light-duty vehicle fleetwide average of 22 miles per gallon.

  Bus lanes only: 3,300 gallons/day
  Carpool lanes only: 1,700 gallons/day

- Physical Mobility - This measure would improve traffic flow at congested points.

Status

The ramp metering measure was combined with the bus and carpool lanes measure early in the process. It was felt that these measures needed to be reviewed simultaneously. The EMTF and the MTC accepted this recommendation, but felt that the AQMP planning effort was an inappropriate study to propose specific locations for HOV freeway facilities. Rather the concept was endorsed, included in the AQMP and specific location decisions were left to Caltrans and MTC on an individual project basis.

## 3. TRAFFIC ENGINEERING IMPROVEMENTS

### Description

Traffic flow can be improved by a number of small projects which redesign intersections or small street segments. However, if overall capacity were increased, and more trips generated, there could be a negative air quality effect.

### History

Individual cities do have programs of traffic engineering improvements; this was a major effort of the Federal TOPICS (Traffic Engineering to Improve Capacity and Safety) program. The Transportation System Management Element (TSME) also focuses to some extent on these types of improvements. However, improvement in traffic flow is the primary goal, with air quality a secondary benefit.

### Literature Search

- (Reference 9) - Estimates for the South Coast Air Basin are that redesign of streets and intersections would have a low emission reduction potential for all pollutants.

- (Reference 14) - Operational and flow improvements do not have a high payoff in terms of vehicle emission reductions for several reasons:

  Levels of traffic service and average travel speed in the Bay Area are already high. The net result of flow improvement programs is likely to be preservation of the existing level of service under higher future traffic loads rather than an increase in average travel speed.

  Reductions in emissions with increases in travel speed become quite marginal at speeds above 20 mph, particularly toward 1977 as post-1975 model vehicles become a greater and greater percentage of the vehicle fleet. Current average travel speed is well above 20 mph and the percentage of operations in the high leverage area (below 20 mph) which could actually be affected by operational improvements will produce emission reductions too small to quantify.

### Effectiveness

The emissions reductions potential of this measure was judged to be low, particularly for hydrocarbons. Street congestion in the Bay Area is generally localized, so no dramatic areawide improvements could be expected. In addition, the link (running) emissions decrease substantially in future years, so the emissions base for this measure would be smaller.

Other Impacts

- Physical Mobility - This measure could prove very useful in solving localized congestion problems.

- Safety - Depending on the improvement, traffic safety improvements could be achieved.

Status

This measure was eliminated in the first screening by the Joint Technical Staff and the Technical Advisory Committee. The emphasis at that time was on hydrocarbon controls, and the potential effectiveness of this measure was judged to be minimal. However, traffic engineering techniques may prove promising as a CO control measure and will be evaluated further as part of the continuing planning process.

4. TRUCK REGULATIONS

Description

Trucks, either moving or parked, can disrupt traffic flow, particularly during peak periods. Two actions are possible.

1. Local regulations could require freight loading to be off-street to prevent disruption of traffic, or

2. Freight deliveries could be prohibited during peak periods.

History

Currently, there are peak period parking restrictions in CBD areas which do prevent deliveries at these times. In addition, many zoning regulations call for off-street freight facilities in new construction.

However, deliveries are not normally scheduled during peak hours, therefore significant problems from this source are not widespread.

Literature Search

- (Reference 16) - Studies have shown that the major truck movements in the CBD occur between the hours of 10 a.m. and 2:30 p.m.. Despite this voluntary scheduling, further restrictions during peak hours may be desirable. Restricting loading zone hours may be the best way of accomplishing this.

- (Reference 13) - This study in the Washington, D.C. area estimated that peak period truck VMT could be reduced by 4%. However, significant opposition, including legal challenges, could be expected.

- (Reference 18) - Although the actual number of affected trucks is quite small, the congestion reduction could be significant because the parking movements of trucks are fairly disruptive to traffic. EPA proposed this type of measure in the New Jersey TCP but withdrew it after receiving adverse comments from the affected industries.

Effectiveness

Based on the literature review and knowledge of conditions in the Bay Area, the effectiveness of this measure as an oxidant strategy was judged to be minimal. Because of labor costs and current parking restrictions, peak hour deliveries are already avoided whenever possible. Thus truck movements do not unduly disrupt traffic flow.

## Other Impacts

Implementation costs would be small, but enforcement costs could be significant. Business costs would increase.

Significant opposition could be expected from business and the trucking industry.

## Status

This measure was dropped in the first review by the JTS and TAC. They believed that only a small congestion decrease could be expected, and the resulting change in hydrocarbon emissions would be insignificant.

## 5. STAGGERED WORK HOURS

### Description

This program would shift the daily work schedule so that all employees would not arrive and leave at the same time. This could take the form of (a) "staggered hours," where subgroups of a total work force operate on a fixed schedule, or (b) "flextime," where employees are given the option of determining their own hours within certain limits. This measure could improve air quality by (a) reducing congestion, (b) spreading early morning emissions, and (c) providing employees with an opportunity to adjust their schedules to accommodate other modes of travel.

### History

A number of Bay Area employers have adopted staggered work hours, which have generally proved successful, with improved morale, productivity, and fewer congestion problems. The city of Sunnyvale is currently working on a city wide staggered work hours program in an attempt to relieve traffic congestion. New York City coordinated a staggered work hours program with employers in Manhattan. There was a reduction in congestion, particularly on the transit systems.

### Literature Search

- (Reference 13) - A staggered work hours program in the Washington D.C. area would reduce VMT in the morning peak period by 4%, but this traffic would just be re-distributed throughout the day.

- (Reference 14) -"Potential for air quality improvement in the Bay Area as a result of staggered work hours appears minimal. In the approach corridors to downtown San Francisco, where greatest impact of such work staggering might be expected, peak period congestion already extends over more than an hour both morning and afternoon. This indicates the extent to which natural and capacity enforced staggering already exists and the futility of further staggering efforts.

  In areas of dispersed employment activity staggering is less meaningful. Dispersed employment location and unfocused trip patterns in themselves result in a spread of traffic over the street and highway system.

  Achievement of meaningful results through work staggering appears to require spread of starting and quitting times over more than two hour periods. This seems difficult because of constraints both of human temporal activity patterns which have become ingrained and the requirement in many business activities for maximal overlap of working hours with other local work activities and with business hours in the eastern time zones.

The air quality problem in this region results from excessive areawide hydrocarbon emissions on an all day basis. Such a problem responds most directly to decreases in total daily areawide VMT. Staggered work hours do not decrease total daily VMT but simply spread the time of VMT generation. Such a strategy is most applicable when the problem is a short duration, localized concentration of traffic flow. Staggered work hours may tend to reduce the potential for car pooling, a measure which does relate well to a hydrocarbon problem as it tends to directly reduce VMT. For these reasons, staggered work hours are not identified as a high-payoff pollution control measure for the Bay Area."

Effectiveness

This measure is estimated to have minimal potential as an oxidant strategy because it would re-distribute hydrocarbon emissions, rather than reduce them. This conclusion was based on the literature review, particularly the Bay Area study (Reference 14).

Other Impacts

There would be a reduction in traffic congestion, with an attendant energy savings. A positive impact on employee morale and productivity could be anticipated.

Status

The JTS and TAC dropped this measure in their initial review because of its low potential as an oxidant strategy. Based on some initial sensitivity runs with the LIRAQ air quality model, it was determined that a temporal re-distribution of hydrocarbons would not have a significant effect on the peak oxidant concentration.

This measure may prove useful as a Carbon Monoxide control strategy in the continuing planning process.

## 6. FOUR-DAY WORK WEEK

### Description

The standard work week would be shortened to four days, with the work day lengthened and/or the weekly hours worked shortened. One-fifth of the commute travel could be eliminated, but the additional leisure time could generate other recreational or shopping trips.

### History

A number of agencies in the Bay Area have experimented with the 4 day work week. Nationwide, it is estimated that more than a million workers are on the 4 - day work plan (Reference 18). 85 - 95% of the firms that have tried this concept have retained it.

### Literature Search

- (Reference 18) - This study estimates that substantial peak period congestion could be eliminated if the 4 - day work week was widely adopted. However, a VMT savings is unlikely because: 1) increased recreational travel on the extra day off would occur, 2) there would be additional travel generated by part-time second jobs, and 3) the reduced congestion could induce workers to live further out, particularly since they would only be traveling 4 days.
- (Reference 10) - The 4 - day work week appears questionable because of substitute travel which is likely to occur.
- (Reference 14) - This Bay Area study estimated that the 4 - day week would reduce VMT generated in work commute travel. However, indications are the increased recreational and other non-work travel would fully replace if not exceed the reductions in VMT resulting from

decreased work commuting. This measure was thus not recommended for inclusion in the TCP.

### Effectiveness

Based on a review of the literature, the emissions reduction potential of this measure appears to be low. The decrease in commute traffic would be offset by an increase in recreational and other travel.

### Other Impacts

Peak period traffic congestion could be substantially reduced.

The costs of implementing the program, primarily survey and data collection costs before program implementation, would be low.

A net energy savings is likely, despite the increased recreational travel, because of the reduced congestion.

Status

The Joint Technical Staff and the Technical Advisory Committee recommended deletion of this measure in their initial review. They believed that the probable travel reductions would be quite low. In addition, the problem of employer and worker acceptance would preclude extensive application of this measure.

## 7. ADDITIONAL VEHICLE LICENSE FEE

### Description

This measure could take a number of forms. It could be a tax increase on all cars, or one which would impose a progressively heavier tax on the more polluting cars. Another alternative would be to tax second or third cars in a household and so reduce mobility.

### History

The California vehicle registration fee for automobiles is related to the value of the vehicle. In addition to the base registration fee, there is a tax based on the value of the vehicle.

The MTC Regional Transportation Plan lists this measure as a potential funding source requiring further research and evaluation. The following possibilities are cited[6]:

> "PROGRESSIVE TAXATION ON VEHICLE TYPE AND OWNERSHIP
>
> Several automobile taxation devices are proposed which, in addition to providing funding for public transportation systems, also serve to discourage unnecessary automobile ownership.
>
> a. Within existing transit service areas -- as defined by MTC -- an additional charge, for example $10 per annum, should be made on the ownership of a second automobile registered to any single address or dwelling unit. Then, a $20 per annum charge will be levied on a third car registered to a single dwelling unit, and so on.
>
> b. In all areas of the Region, the fee for private motor vehicle (passenger car) licensing will include a component -- in addition to present components based on values, etc. -- graduated progressively upward according to engine horsepower (the single most easily measured variable related to fuel consumption, emission of air pollutants, and consumption of raw materials.)
>
> c. The base charge for passenger car registration should be increased (e.g., $10).
>
> Administration, calculation and collection of these added motor vehicle taxes would be accomplished by the State of California Division of Motor Vehicles if the State Legislature passed the necessary legislation. The resultant added revenues would be allocated by MTC for public transportation purposes."

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6 Metropolitan Transportation Commission, "Regional Transportation Plan", issued 1973 and updated annually.

## Literature Search

- (Reference 5) - The auto registration tax could be based on various formulae including vehicle weight, horsepower, number of vehicles in household, fuel consumption rating and emission rating. It is estimated that 42 percent of the regional VMT in the Southern California Air Basin is generated by second and third family cars.

- (Reference 13) - The imposition of a once per year charge such as a registration fee has a minimal impact on the decision to buy a second auto and has an even smaller impact on day-to-day decision regarding modal choice.

- (Reference 14) - This study envisions this measure as a surcharge based on the emission class of the vehicle. It would probably not cause persons to give up second and third family cars, but might provide an incentive for voluntary retrofits of older vehicles. However, it would impact lower income groups particularly hard.

## Effectiveness

Based on the previous studies, it appears that the registration fee increase would need to be quite high, perhaps in excess of one hundred dollars, to have a noticable effect on car ownership.

## Other Impacts

Implementation costs of this measure would be low, since it could be administered through the Department of Motor Vehicles. This measure would be a significant burden on lower income groups. Considerable adverse public reaction could be expected.

## Status

This measure was dropped in the initial screening by the JTS and TAC for the following reasons:

1) The fee would have to be very high to have a significant effect on car ownership. Such a fee would be unfair to lower income groups.

2) The fee would have no effect on day-to-day mode choice decisions.

However, as noted in the earlier reference from the MTC Regional Transportation Plan, some increase in the registration fees may be necessary to raise revenues for transportation improvements.

## 8. REGISTRATION LIMITS

### Description

Instead of taxing vehicles with higher pollution potential, this measure would set limits on the numbers of such vehicles which could be registered.

### History

EPA initially proposed a ceiling on motorcycle registrations in its TCP. This was designed to prevent a shift to this more polluting mode as a result of other automobile controls. This was dropped in the final version on the understanding that emission control standards for motorcycles would be promulgated.

### Literature Search

- (Reference 9) - This study for the South Coast Air Basin estimated that the effectiveness of this measure could be quite high if it were applied stringently. However, the constitutionality of the tactic was questioned.

### Effectiveness

The emission reduction potential of this measure was judged to be quite low because there are currently very few classes of vehicles which do not have vehicle emission standards. It is conceivable that a limit might be placed on the total number of vehicles registered, but because of the stringent emission standards on new vehicles, even this drastic measure would have only a small effect.

### Other Impacts

There would be formidable implementation problems, particularly from an equity standpoint.

Considerable adverse public reaction could be expected.

### Status

The JTS and TAC eliminated this measure in their first review. They believed it was not warrented for any particular class of vehicles because of the extended application of the vehicle emission controls. A limit on total registrations was thought to be impracticable because of the formidable implementation problems.

## 9. BETTER ENFORCEMENT OF PARKING REGULATIONS

### Description

There are many current parking regulations which, if strictly enforced, could discourage certain auto trips. Notable among these are the restrictions on long-term parking which could persuade some commuters to take transit. Other actions, such as enforcement of truck loading zones, could result in a smoother flow of traffic.

### History

Stricter enforcement of long-term parking regulations has been advocated at various times. The purpose has usually been to provide more short-term parking and not related directly to air quality.

### Literature Search

No reference to this measure as an air quality tactic was found.

### Effectiveness

Based on contacts with enforcement officials in the larger cities, excessive violations do not appear to be a problem. Therefore, it is estimated that better enforcement would produce only minor benefits.

### Other Impacts

Additional enforcement costs are likely to be quite high.

Some improvement in traffic flow is likely from better enforcement of loading zones.

### Status

The JTS and TAC recommended that this measure be studied further as part of an overall parking strategy. Based on contacts with local officials, enforcement was not considered a significant problem. Thus, this measure was not recommended to the EMTF and the MTC.

## 10. LIMIT NUMBER OF PARKING SPACES

### Description

The intent of this measure is to reduce the available parking and so limit the number of autos which can effectively use the controlled area. There are two implementation options: (a) limit the construction of new parking facilities, and (b) cut back the number of parking spaces already available.

### History

EPA proposed in the 1973 TCP that spaces in public parking facilities be reduced by 20%. This requirement was dropped in the final version but a permit was required before any new parking facility of 50 or more spaces could be built. This provision was to remain in effect until a parking management plan was completed.

Current zoning regulations generally require a minimum number of spaces for any new structure. The intent is to prevent overloading of street space. However, these provisions may indirectly degrade air quality by inducing automobile trips to the new structure.

### Literature Search

- (Reference10) - This study for San Diego looked at six parking management scenarios. The most stringent scenario, in which severe restrictions were placed on trips to all control areas, is estimated to reduce VMT by 1.3% in 1985.

- (Reference 13) - This study estimated that eliminating 10% of all privately owned parking in the core area of Washington, D.C. would cause a 1% decrease in vehicle work trips.

- (Reference 1 ) - One of the measures investigated in this 1975 Bay Area Study was a change in parking requirements. This study found an oversupply of parking in most cities in the region, with only about 60% of the available spaces being utilized. Because of this, there would be a substantial time lag before the effects of a freeze on new parking facilities were noticed.

### Effectiveness

The mode-split submodel was used to assess the effects of this measure. To simulate a freeze (1977 levels) on parking supply in the major CBD's, an increase in walking time at the trip-end was assumed. On this basis, it was estimated that, for home to work travel, vehicle trips would decrease by 7%, with transit ridership increasing 23% and carpools decreasing by 6%

This would translate to a reduction in the 1985 daily emissions inventory of 0.4 tons of hydrocarbons, 5.5 tons of carbon monoxide, and 0.3 tons of $NO_x$.

## Other Impacts

The potential energy savings from this measure would be 11,600 gallons of gasoline daily by 1985.

This measure could be implemented through present zoning powers. However, considerable opposition could be anticipated from downtown merchants and the parking industry. This also has the potential of placing central cities at an economic disadvantage relative to the suburbs.

## Status

The JTS and TAC recommended study of the measure as part of an overall parking strategy. The measure was analyzed, but staff did not recommend it for inclusion in the plan because the emissions reduction was not large enough to offset the impact on the central cities. The EMTF and the MTC concurred.

## 11. PROHIBIT ON-STREET PARKING DURING PEAK HOURS

### Description

This measure is designed to improve air quality primarily by improving the flow of traffic. It also serves to discourage certain trips since it limits the available parking.

### History

Prohibiting peak-period parking on major arterials is fairly common throughout the Bay Area. Cities do this to increase the traffic capacity.

### Literature Search

No references to this control as an air quality measure were found.

### Effectiveness

On the basis of an informal survey, it was determined that this measure is already extensively used throughout the region. Further efforts in this area were estimated to have minimal benefits.

### Other Impacts

Traffic flow would improve on streets where this measure is implemented. There is a small potential that this increase in capacity may actually encourage additional trips.

Enforcement costs for this measure are high.

### Status

This measure was recommended for further study as part of the overall parking strategy by the JTS and TAC. Subsequently, it was decided not to recommend it as part of the plan because it is already applied throughout the region.

12. AREA LICENSE

Description

A special license would be required to bring a car into certain designated areas. This could take the form of a windshield sticker which must be displayed to travel or park in the area, some sort of cordon control, or even electronic sensors.

History

In the past few years there has been increased interest throughout the world in the possibility of imposing user charges to discourage automobile travel in major urban areas. Singapore instituted a program which has been successful but no cities in Europe or North America have tried this concept. A similar type of program was under discussion in Berkeley but was not pursued.

Literature Search

- (Reference 1) - This measure would cause an immediate reduction in work-related vehicle travel. However, there is likely to be spillover parking on the periphery of the controlled area, much like the current situation on university campuses. In the absence of regional control, employment centers would relocate outside the restricted areas. Non-work travel would likely divert immediately to unrestricted areas, so there would be no net decrease in travel.

- (Reference 3) - This paper recommends supplementary licenses to reduce congestion in core areas. For an experimental program, windshield stickers would be the cheapest, and most flexible alternative.

- (Reference 9) - This L.A. area study projected a low emission reduction potential for this measure.

Effectiveness

Depending on the level of application, this measure could be quite effective in reducing vehicle work trips in the short-term. However, for non-work trips, and in the long-term, for work trips, diversions would likely occur which would offset the initial reductions.

Other Impacts

This measure would cause a shift in economic activity if employers or businesses react by moving out of the controlled area.

Considerable public opposition could be expected, particularly from merchants in the controlled area.

Traffic congestion in the area could be dramatically reduced; however, traffic on the periphery would likely increase.

## Status

The JTS and TAC rejected this measure in their first review. They believed that traffic could be reduced more easily through parking restrictions. Moreover, the chance of adverse secondary impacts was too large to justify this measure.

## 13. AUTO FREE ZONES

### Description

This measure involves the designation of areas within a city (e.g., CBD's) where vehicles are prohibited, with the exception of buses, taxis and emergency vehicles. This technique can result in an improved pedestrian environment and would encourage people to use transit for the entire trip.

### History

This concept has been tried in a number of European cities, and has proved quite successful.. The primary example of these zones in the U.S. has been the shopping mall, generally limited to one street. The City of San Francisco has endorsed an auto control zone in the transportation element of the Master Plan.

### Literature Search

- (Reference 19) - Auto-Free Zones can improve pedestrian linkages and amenities, and can provide better access to transit vehicles. They will also lead to a reduction in localized air and noise pollution levels. However, the broader scale impacts, e.g. whether they induce significant shifts from auto to transit travel, are not as clear.

- (Reference 9) - A proposed auto-restricted zone for downtown L.A. would reduce VMT by 0.6%. This represents a low potential for reduction of hydrocarbon emissions.

- (Reference 1 ) - This Bay Area study estimated that auto-free zones would be relatively effective in reducing travel demand and hydrocarbon emissions. It concluded that a sizable mode shift would occur for work-related travel, while non-work trips would consolidate single visits, or divert to other locations.

### Effectiveness

The modal-split submodel was used to forecast the effects of an auto-control zone in San Francisco. A 5 minute increase in walk time at the end of the trip was assumed for automobile users; transit vehicles would be allowed into the zone. The model forecast a 3% decrease in auto trips, and a 12% increase in transit trips to the CBD. This would result in daily reductions (1985) of 0.1 tons of HC, 2.3 tons of CO, and 0.1 tons of $NO_x$.

### Other Impacts

The reduction of noise and traffic conflicts would improve the ambience of the area. Pedestrian safety and mobility would be enhanced.

An energy savings of 5000 gallons of gasoline per day (1985) can be expected.

Initial adverse reaction can be expected, especially for economic reasons. However, European experience suggests that economic impacts are ultimately positive.

Since cities have the authority to restrict parking and to close streets, no legal impediments are anticipated.

Implementation costs would be moderate: primarily for street diverters, signal modifications, and reconstruction of sidewalks where desired.

<u>Status</u>

An auto-control zone in San Francisco was examined as an initial experiment to determine the feasibility of these zones elsewhere in the region. However, the City of San Francisco believed that the concept was not sufficiently detailed and asked that it be studied further as part of the continuing planning process (CPP). MTC supported the San Francisco position.

## 14. GAS RATIONING

### Description

Since air pollution is directly related to the consumption of gasoline, an obvious control strategy is to restrict or regulate its use. Control could either be at the distribution end (e.g., the regional and county level), or by individual rationing (e.g., by registered vehicle, licensed driver, household, or population).

### History

Gasoline rationing was implemented during World War II as a conservation measure, and although the rationing system had several shortcomings, it was effective in conserving gasoline and reducing VMT. For example, during 1943, total nationwide driving was reduced by 33% from total mileage in 1941.

EPA proposed gas rationing in its 1973 TCP promulgation for a number of metropolitan areas, including the Bay Area. EPA expressed serious reservations about the feasibility of this strategy, but its legal mandate left no other alternative.

The Federal Department of Energy is developing a standby gasoline rationing program which the President can invoke in the event of a reduction in oil supplies.

### Literature Search

- (Reference 6) - The WW II experience demonstrated that gas rationing can be effective. However, the current social-economic climate is quite different from that prevalent during WW II. The higher standard of living, the suburbanization trend, and the greater dependance on the auto make present public acceptance of gas rationing highly unlikely.

### Effectiveness

The level of rationing can be designed to achieve any specified reduction in travel. However, since automobiles will contribute only 15% of regional hydrocarbon emissions in 1985, the rationing program would be working from this relatively small base.

### Other Impacts

Significant lifestyle changes would be needed. The Bay Area economy would suffer. Implementation problems would be significant, and considerable public opposition could be expected.

Energy savings could be substantial.

### Status

In their first review, the JTS and TAC recommended retaining this as an option. After the baseline emissions inventory was completed, however, it became evident that the emissions from the transportation sector were much less than in earlier years. The potential benefit from this measure did not seem to justify the severe social and economic impacts. Staff did not recommend the measure as part of the draft plan.

## 15. ROAD PRICING TECHNIQUES

### Description

This measure could be implemented in two distinct ways. In one, a fee would be charged for the use of certain raods. This is similar to a toll, except that it is more widespread and would likely not be collected at a tollbooth. Instead, some system of in-car meters or electronic scanning devices might be used as automatic billing devices. The second form is a congestion toll, where the rates would increase with the level of congestion.

### History

Actual experience with this measure is quite limited. The Urban Institute has been studying the potential of this approach since 1973 and UMTA is apparently interested in funding a demonstration program.

### Literature Search

- (Reference 3) - Four methods of applying road user charges are possible: 1) Conventional toll booths, 2) Automatic vehicle identification, using off-vehicle roadside scanners, 3) On-vehicle meters, and 4) Supplementary licenses. This last combines flexibility with low implementation cost.

- (Reference 11) - The current system of charging road users a fixed fee (gas tax) regardless of the time they travel leads to an inefficient highway program. High capacity roads must be built to accomodate the peak traffic; however, the cost of these additional lanes is spread over all users. If the cost of this additional capacity were changed to the peak user, the travel demand would fall, leading to a more efficient allocation of resources, and other benefits such as air quality.

### Effectiveness

On the basis of the literature search, the potential emissions reductions from this measure are relatively promising, particularly if it were implemented on a large scale. However, the actual experience with road-pricing is very limited.

### Other Impacts

Combining this with the peak pricing concept could lead to a more efficient allocation of resources. Energy savings could be substantial.

Costs to the auto user would rise. The actual costs of implementation would depend on the technique chosen; the electronic scanners or meters would be the most expensive.

This measure would be highly unpopular, because it would involve a user charge, and because it would be regressive in its effect on low income persons.

Status

This measure was dropped in the initial review by the JTS and TAC. Although the measure appeared promising, they believed that the technology of electronic sensors was not readily available. Also, because of its visibility, public opposition would be high. They concluded that similar reductions could be achieved through parking strategies, and would probably be more acceptable.

## 16. INCREASED PARKING COSTS

### Description

A parking tax could be levied by the cities on commercial parking, designed so that it would apply primarily to work trips. Thus auto use would be discouraged by increasing the overall commute cost.

### History

San Francisco levied a 25% tax on parking receipts in 1970. Some operators responded by absorbing the tax, thereby reducing their profits. The tax was reduced to 10% in 1972, but was recently raised to 15%.

EPA included a parking surcharge in its TCP. This was to apply on weekdays between the hours of 7 a.m. and 7 p.m.. The surcharge was scheduled to be 25¢/hr. by 1976. The proceeds of this tax were to be used for mass transit. EPA later removed all parking surcharges because of Congressional opposition.

### Literature Search

- (Reference 1 ) - This study investigated the effects of imposing a $1.00 daily surcharge on all off-street parking spaces. This would only be levied on single-occupant vehicles. It determined that the reduction in trips, VMT, and HC emissions were significant (6-9%). The study concluded that this was the most effective parking control mechanism, but should only be applied to work trips.

- (Reference 16) - The use of parking fees as a pricing mechanism to change automobile use in high density, congested areas has some significant constraints. These include:

  - Parking demand is inelastic with respect to price. The coefficient of price elasticity is estimated to be -0.30.

  - A significant percent (15 to 50 percent) of the traffic in congested areas, such as central business districts, is through traffic.

  - Typically, less than 20 percent of urban trips (less than 5 percent in large urban areas) are to the CBD where parking is not free.

  Under these conditions a 100 percent increase in parking cost might yield a 15 to 25 percent restriction in traffic within the CBD.

### Effectiveness

The effects of a parking tax on commuters was investigated using the split sub-model. A daily parking cost increase of $1.00 would reduce CBD-bound work trips by 5%. The reduction in 1985 daily emissions would be 0.3 tons of HC, 3.9 tons of CO, and 0.2 tons of $NO_x$.

Other Impacts

This measure could lead to a gasoline savings of 8000 gallons/day.

Extensive revenues would be generated, which could be used for transit.

Parking lot operators would probably experience some decline in revenues.

Status

Staff recommended inclusion of this measure in the plan as a means of financing transit improvements. The proposal was for a 35% tax for vehicles entering paid lots between 6 and 10 a.m.. The MTC, however, did not wish to include this measure because it singled out the higher density cities which already have paid parking. The Commission will consider this measure if the inequities can be minimized.

## 17. MINIMUM PARKING FEE AT LARGE SHOPPING CENTERS

### Description

Most of the measures that were considered focused on the work trip. Other trips, such as shopping, are important in the formation of air pollution but are not as susceptible to diversion to transit. However, many of these trips are made to purchase only one or two items. If the shopper were to consolidate these single trips into one or two weekly trips, the air quality effect could be important. To encourage this consolidation of trips, a minimum 50¢ parking fee at shopping centers that maintain over 500 parking spaces was proposed.

### History

Shopping centers almost always provide free parking, primarily because most of the shopping centers are located in the suburbs, where land is readily available. There is virtually no experience with charging a minimum parking fee at these facilities.

EPA included a surcharge on free parking spaces in its TCP. This was to be a yearly amount of $450 per parking space by 1976. This provision was later rescinded.

### Literature Search

No references to a measure of this type was found.

### Effectiveness

Staff was unable to quantify the effectiveness of this measure because of the lack of experience with this type of action. However, we estimate that shopping trips in 1985 will generate 53 tons of HC, 826 tons of CO, and 39 tons of $NO_x$ daily. Moreover, there are 119 shopping centers in the Bay Area that have more than 500 parking spaces.

### Other Impacts

It is possible that adverse economic impacts could be attributed to this measure if shoppers choose to forgo rather than consolidate trips to regional centers. It is also possible that the measure may discourage the building of large shopping centers if developers feel that customers would be diverted elsewhere or that capital and maintenance costs would make it less profitable for them to operate in such a manner.

This concept may lead to the creation of smaller shopping centers serving a more localized clientele. Alternately, more facilities, such as banks or medical offices, may locate in large centers to attract shoppers interested in making only one trip.

Adverse impacts on low income persons may be expected. A 50 cent parking charge would have a minor effect on middle income persons.

Gasoline consumption will drop as persons consolidate their shopping trips.

Individual cities could implement this measure. However, legal problems do exist. Courts have not generally upheld efforts of local agencies to regulate prices of a particular business. The cities could presumably impose a business license tax on these commercial facilities. However, the businesses could not be required to collect it via a parking fee. One approach might be to require as a condition of acquiring a permit that a business agree to collect a minimum fee for each car using a parking space. Otherwise, special legislative authority would be needed.

Considerable revenues (probably more than $30 million/year) would be generated and could be used for public transit.

Status

Staff initially considered recommending this measure as part of the plan because of the importance of shopping trips. However, because so many of the impacts were still unknown, and the initial public reaction was very negative, it was decided to drop this measure.

## 18. ELIMINATE FREE EMPLOYEE PARKING

### Description

Employers located outside the CBD's virtually always provide their employees with free parking. To encourage these employees to shift to transit or carpools, this measure specifies a $1.00 parking fee be levied at all employee lots of 500 or more spaces.

### History

EPA included an employee parking fee in its 1973 TCP. This provision was applicable to all employers providing 70 or more employee parking spaces. A fee was to be charged equal to the commercial rate plus a surcharge, to all single-occupant cars. By 1977, the surcharge would have been $2.50. This provision was later rescinded when the parking regulations were dropped.

MTC has listed this measure as a possible source of funding. Specifically, the RTP states:

> EMPLOYEE-LOT PARKING TAX
>
> MTC should investigate requesting authority from the legislature to levy a parking tax on "employee" parking facilities which are presently provided free of charge in existing transit service areas. The tax on each parking space provided free to employees should ultimately approximate the charges which would be paid to a fee lot operator for similar services. Initially the tax would be a flat rate per space per year, levied on the organization providing parking. This rate would be established on an annual basis and would vary according to the average cost of paid parking in the same jurisdiction. Deducted from the total parking tax obligation of any organization would be the cash value of any transit tickets provided free of charge each year to employees. The proceeds from this tax, which would apply only in those areas which are certified by MTC to have minimum levels of trunk and local transit service, would apply to the capital and operating support of public transportation services.

### Literature Search

- (Reference 1 ) - A $1.00 per day surcharge applied to work related parking uses could reduce vehicle trips by 5-8%, VMT by 4-8%, and hydrocarbons by 6-9%. Significant adverse social and economic consequences are likely.

- (Reference 7 ) - A 16% decrease in vehicle work trips could be expected if commercial parking rates were applied to employee parking lots.

### Effectiveness

The effects of a $1.00 fee at employee parking lots are estimated to be a 3% decrease in vehicle trips to these areas. This would reduce HC emissions by 0.9 tons, CO by 13.3 tons, and $NO_x$ by 0.8 tons daily in 1985.

## Other Impacts

Transit ridership and carpools would increase. Traffic congestion would decrease. Significant energy savings would result.

Businesses and industries may be discouraged from moving into the region because of this measure. Considerable opposition to this measure from labor could be expected.

Substantial revenue, roughly estimated at $35 million per year, would be generated. This could be used to support mass transit.

## Status

Staff did not recommend this measure as part of the Plan. The social and economic inpacts, as well as the legal obstacles, did not seem to justify the potential benefits. In addition, the EPA experience and the Parking Management study indicated that this measure had little chance of public acceptance.

## 19. ADDITIONAL GASOLINE TAX

### Description

The gasoline tax could be increased, thus adding to the cost of travel. The mechanics of implementation would be relatively simple, since this would only require increasing an existing tax.

### History

The State and Federal governments currently levy a gasoline tax as a road-user charge. The total (State and Federal) tax in California is currently 11¢ per gallon.

### Literature Search

- (Reference 15) - Based on the "energy crisis" of 1973-74, the price elasticity of gasoline is approximately -0.1 (i.e., a 10% price increase would reduce demand by 1%) in the short run. It was concluded that it would be premature to advocate a gas tax increase as an air quality measure until further information on gas price eleasticity is obtained.

- (Reference 19) - Based on limited data, a gasoline price increase seems to have relatively little impact on the amount of travel by automobile. Constraining the supply of gas seems to have a much greater effect.

- (Reference 13 ) - This Washington, D.C. study estimated that a 10¢ per gallon fuel tax increase would reduce vehicle work trips by 2%. A 20¢ increase would give a 3% reduction.

### Effectiveness

A 15¢ per gallon increase in the gas tax was tested with the travel model. It was estimated that this would reduce vehicle work trips by less than 1%. Emission reductions in 1985 would be:

HC - less than 0.1 ton/day
CO - 0.8 tons/day
$NO_x$ - less than 0.1 ton/day

### Other Impacts

The application of this measure would probably produce a long-term shift toward smaller, more fuel-efficent cars.

Revenue from this increase is estimated to be more than $500,000 daily.

Low income people and others not having access to transit would be penalized most severely.

### Status

Staff did not recommend this measure as part of the plan because of its minimal effectiveness.

## 20. INCREASED TOLLS

### Description

Bridge tolls would be increased to reduce the volume of autos using the facility and to generate revenue which could be used to finance improvements in the transit system.

### History

Bridge tolls were originally imposed because of the high construction cost. However, excess revenue from the Bay Bridge was used to pay for the BART tube under the Bay, and the Golden Gate District has used its bridge revenues to support transit.

In 1975, MTC was given authority over the level and use of tolls on the state-owned trans-bay bridges. Tolls on the Bay, San Mateo, and Dumbarton bridges were raised to 75¢ and excess revenue (an estimated $8 million annually) is used to support the transit systems in the vicinity of the bridges.

### Literature Search

- (Reference 19) - Both -0.17 and -0.2 are cited as being representative elasticity values for most urban bridge toll increases. However, the individual elasticity depends to some extent on what portion of the total trip cost the toll represents.

- (Reference 14 ) - This 1973 Bay Area study estimated that a $2 toll increase would only yield a net VMT reduction of 0.6% for the peak hour and 1.4% for 24 hour application. The travel time and cost of the commute trip to San Francisco is already so high that tolls would have to be raised on the order of $10 per round trip to cut vehicular traffic into the city in half.

### Effectiveness

A peak-period toll of $1.25, with an off-peak toll of $1.00, was assumed. The mode-split submodel estimated that a 4% reduction in commuter vehicles entering San Francisco would occur. This would reduce 1985 daily emissions by 0.2 tons of HC, 3.1 tons of CO, and 0.2 tons of $NO_x$.

### Other Impacts

A reduction in peak period traffic across the bridges can be expected, wtih attendant energy savings.

There would be a significant increase in revenue which could be made available for future transit extensions.

Implementation authority already exists with the MTC for all but the Golden Gate bridge. Based on the recent toll increase, considerable public reaction could be expected.

Commuters would experience a financial burden. However, the commuter is often able to use public transportation or carpools to eliminate the additional expense. Low income persons would not be adversely affected if alternative transit service is available.

Status

Although this measure is not very effective as an air quality measure, staff recommended its inclusion in the plan because of its revenue generating ability, and also because the implementation authority already existed.

In reviewing this measure, MTC stated that it would support the concept of bridge toll increases when it can be shown to be necessary to fund continued or improved transportation services within the same corridor. MTC does not support bridge toll increases as a penalty device.

MTC considers bridge tolls to be an interim solution to the transit financing problem. MTC's longer-range recommendation is for the State to uniformly tax all automobile users (probably with a gasoline tax) to support public transit. After such a measure is imposed, the bridge tolls would be eliminated to reduce the related inconvenience, inequity and congestion.

## 21. "SMOG CHARGES"

### Description

This measure would assess an additional charge on the auto driver for the pollution generated by the automobile, thus encouraging a shift to other forms of transport or to less polluting cars. The implementation could be accomplished through some of the measures already tax or registration fee, possibly accompanied by some rebate scheme for those autos with superior emissions control equipment.

### History

To our knowledge, there have been no attempts to tax vehicles on the basis of their smog characteristics. Recently, a bill which would authorize an emissions tax on stationary sources was considered but eventually defeated by the California legislature.

### Literature Search

- (Reference 5) - A vehicle emissions tax would become less effective in future years as vehicles with superior emission controls are phased in. A variation of this tax would be a mileage charge, which would be assessed annually when the vehicle is registered.

### Effectiveness

It was assumed, for analysis purposes, that this measure would be similar in effectiveness to an increased gas tax.

### Other Impacts

This measure would result in higher costs for consumers. Since low-income people probably own many of the older, more polluting cars, this would prove more burdensome to them. However, additional revenue would be available for transit development.

### Status

On the basis of the gas tax analysis, the effectiveness of this measure was judged to be minimal, particularly since the majority of vehicles now have improved emission controls. Accordingly, staff did not recommend this measure as part of the plan.

## 22. COMMUNICATIONS SUBSTITUTES

### Description

This measure is intended to reduce the need to travel by employing communications substitutes. The telephone, photocopying techniques, and computer data transfers are all examples of a communications link substituting for travel.

### History

Communications technology is developing rapidly. A number of studies have identified advances, potential for travel substitution, and the problems. However, the application of communications technology has not been vigorously pursued as an air quality strategy.

### Literature Search

- (Reference 10)- The potential exists for communications substitutes for both work and non-work trips. A number of implementation obstacles have been identified: 1) Technological state-of-the-art, 2) High equipment cost, 3) Slow market acceptability, 4) Regulatory and legal obstacles, and 5) Institutional and political problems. In spite of these obstacles, this San Diego study included this measure in their recommended strategy.

- (Reference 9) - This L.A. area study concluded that communications substitutes have a low potential for reducing emissions.

### Effectiveness

On the basis of the literature review, this measure was determined to have only a low potential for reduction of emissions in the short-term.

### Other Impacts

Significant social impacts are likely with wide application of this measure. At the present time, the user cost is high for much of the new technology.

### Status

The JTS and TAC recommended dropping this measure in their initial review. They believed that the potential for short-range benefits was quite limited. In addition, they thought that a single region would have difficulty in influencing implementation of this measure.

## 23. GOODS MOVEMENT CONSOLIDATION

### Description

This measure would reduce truck travel by consolidating freight deliveries. One possibility is to have a single terminal where the freight is delivered and sorted, and then small trucks would complete the delivery. A second possibility is to have a single receiving point for large commercial buildings.

### History

Apart from grocery chains, which frequently have a central warehouse for shipment consolidation prior to delivery to individual stores, general consolidation terminals have not been implemented to date.

### Literature Search

- (Reference 16) - Consolidated receiving in large buildings in the CBD can substantially reduce the amount of time trucks are parked on the street, thus leading to an improvement in traffic flow.

  Consolidated delivery could conceivably reduce truck traffic in the CBD. This concept is more applicable to "for-hire" vehicles than it is to private vehicles. However, "for-hire" carriers only constitute one-fourth to one-third of the total delivery/service vehicles in the CBD, and many of these carriers route their vehicles so that they enter the CBD fully loaded and leave the area empty.

### Effectiveness

Based on the literature review, and the percentage of total traffic that trucks constitute, the potential emissions reductions from this measure are minimal.

### Other Impacts

Consolidated delivery would involve costs for a terminal and route structuring. However, the operators would probably realize a savings in operating costs.

The freight industry is opposed to this measure (based on an informal assesment conducted by MTC in Spring 1978).

A reduction in traffic congestion is likely.

### Status

This measure was dropped in the initial review by the JTS and TAC because of its minimal emissions reduction potential. In addition, the start-up time would be long enough that the benefits would only be realized in the long-term.

## 24. ADDITIONAL TRANSIT SERVICE

### Description

Improving transit service would increase its availability, decrease the waiting time and in some cases the running time, and generally make transit more competitive with the auto.

### History

In order to lure travelers from automobiles, a reasonable alternative mode of transportation must be provided. Thus, provisions for additional transit service have been a part of virtually every recommended transportation/air quality strategy.

The EPA Bay Area TCP specified that the substantial revenues which would have been generated by the proposed parking regulations were to be used for transit expansion. The MTC TCP identified a 26% increase in transit capacity over the period 1974-77.

The Bay Area's commitment to transit has always been strong. The BART system was built before Federal and State aid became available. Currently, about one-half billion dollars is spent annually for transit support in the Bay Area.

### Literature Search

- (Reference 19) - Traveler response to a number of transit service variables was presented.

    1) Transit frequency changes: The median response to frequency improvements is roughly a one-half of 1 percent patronage gain gain per 1 percent frequency increase. This variable is more important with middle and upper income travelers than with low income people.

    2) Temporal service changes: Service improvements in off-peak hours is listed as more important than peak period improvements.

    3) Bus routing/coverage: Overall expansions of bus transit are estimated to have increased ridership in the range of 0.3 to 0.8 percent per 1 percent increase in regional bus miles of service.

- (Reference 6) - The MTC Transportation Control Plan estimated that transit-related improvements could reduce VMT by 3%.

### Effectiveness

An initial quantification of the travel shifts was made using the mode split submodel. A 20% increase in transit service was tested. This gave a 2-3% reduction in vehicle work trips. The 1985 emissions reductions would be 0.7 tons of HC, 11.2 tons of CO, and 0.7 tons of $NO_x$.

Subsequently, a proposal for a 35% transit ridership increase (1975-1985) was advanced. To determine the emissions reductions, the following assumptions were made:

1) This ridership increase applies to both work and non-work trips.

2) A 19% increase could be expected because of the region's growth. No credit can be taken for this.

3) The additional increase (35-19=16%) in transit work trips is assumed to be a diversion from autos. A vehicle occupancy factor of 1.2 persons/car was used.

4) Only half of the additional increase in transit non-work trips is assumed to be a diversion from autos. A vehicle occupancy factor of 1.5 persons/car was used.

On the basis of these assumptions, it was determined that a reduction of 2.1% of vehicle work trips and 0.5% of vehicle non-work trips could be expected. This would reduce HC emissions by 1.3 tons.

Other Impacts

Substantial capital, operating and maintenance costs would result from this measure.

Providing additional transit service would help low-income and other transit-dependent populations by providing more destinations and more frequent scheduling.

This measure could help encourage a more dense development pattern. As transit becomes more competitive with the auto, it is viewed as a viable alternative and location decisions are made with this fact in mind.

Status

Staff originally recommended a 20% increase in transit service for inclusion in the plan. The MTC, in its review, adopted a two-phased transit improvement strategy. First, they sought the greatest possible improvement which could be financed from the existing commitment of resources to transit. The transit operators subsequently committed themselves to ridership goals based on their adopted improvement programs. These goals amounted to a 28% ridership increase from 1978-83. This would be a 39% increase over the years 1975-83, which would be sufficient to produce the 1.3 ton reduction of HC. Second, MTC adopted a policy seeking additional transit improvements and requested funding support from the state and federal governments for this purpose.

## 25. TRANSIT FARE REDUCTIONS

### Description

There are a number of variations of this measure. One is to simply reduce or eliminate transit fares. A second option is some form of a monthly pass. This could eliminate the psychological impediment of repeated payments and so would encourage the diversion of casual trips to transit. A related option is the coordination of transfers between systems.

### History

Transit fares in the Bay Area have increased very little in the last 20 years. After the recent passage of Proposition 13, AC Transit raised its base fare from 25¢ to 35¢ to offset its loss in tax revenues.

Last year, the legislature passed AB1107 which made permanent the additional ½% sales tax in the BART Counties. However, to be eligible to receive these funds, the transit operator must ensure that fare revenues represent at least 33% of operating costs.

### Literature Search

- (Reference 19) - In general, a 1% decrease in fares will increase transit ridership by 0.4%. However, the response appears to be least in the more heavily transit-oriented cities, and greatest where transit service is less intense.

- (Reference 16) - Across-the-board fare reduction will not serve as a sufficient incentive, by itself, to cause significant increases in transit ridership or decrease auto usage. However, selective fare changes might improve the distribution of riders between the peak and off-peak hours.

### Effectiveness

Based on the literature review, and the fact that transit fares in the Bay Area are low relative to the rest of the nation, the emissions reduction effectiveness of this measure is estimated to be minimal.

### Other Impacts

Transit operators would lose sales tax revenue because they would be unable to meet minimum fare revenue guidelines. Total revenue loss would be substantial. The lost revenue would have to be replaced by increased tax support or service would need to be reduced. Transit riders would realize a savings , but since fares are already low, this would not be substantial. "Joy-riding" by youngsters would increase with attendant problems of vandalism.

### Status

This measure was recommended for further study in the initial review. After further research, the potential emissions reductions appeared minimal. Also, AB 1107 was passed in this period; this measure would conflict with the intent of that law. Thus, staff did not recommend this for inclusion in the plan.

## 26. IMPROVED TRANSIT COMFORT

### Description

This measure seeks to reduce the perceived differences between the auto and transit modes by improving the comfort of transit service. This would be done by providing shelters at bus stops, improving security, more comfortable buses, or other amenities.

### History

The Bay Area transit operators have been steadily upgrading the quality of passenger service. Newer, more comfortable vehicles, and the bus shelter program are some of the more visible efforts.

The MTC TCP listed the bus shelter program as an element of its mass transit strategy. This program has been implemented.

### Literature Search

- (Reference 19) - There is virtually no quantitative data available as to how travelers have responded to transit service amenities in terms of ridership changes. Some attitudinal surveys have been done which suggest that amenity is not one of the most important variables. However, casual or non-work riders would rank amenity higher than their commuter counterparts.

### Effectiveness

The emissions reduction effectiveness of this measure is judged to be relatively small for the following reasons:

1) The literature search indicated that provision of amenities is not one of the prime variables in determining transit demand.

2) The transit operators in this region are already pursuing this measure, so additional efforts are not waranted.

### Other Impacts

There would be a moderate cost associated with the provision of amenities.

### Status

The JTS and TAC eliminated this measure in the initial screening because it was already being implemented.

## 27. BUS AND CARPOOL LANES

### Description

Exclusive lanes for buses and carpools would be provided to give these vehicles a time advantage over single occupant autos. This measure is particularly effective at congestion bottlenecks.

### History

Experience in the Bay Area has shown that buses do benefit from transit priority lanes since they are able to maintain more reliable schedules. Major examples of existing bus priority lanes in the Bay Area include Route 101 in Marin County, Route 280 in San Francisco and through the Bay Bridge Toll Plaza.

The EPA-promulgated TCP specified that a system of bus/carpool lanes totalling not less than 45 miles be established on at least three major highways having three or more lanes running in each direction.

### Literature Search

- (Reference 19) - Priority lane treatments can offer reduced travel time and increased trip reliability. Both are thought to be key factors in the decision to use transit or carpool. Nevertheless, improved travel times and reliability will only induce commuters to use high-occupancy vehicles if other determinants of modal choice, such as frequency of transit service, are favorable. New transit riders or carpoolers are apparently not drawn disproportionately from competing high-occupancy modes when priority lane advantages are provided. Opening of priority facilities to both carpools and buses seems to induce the maximum shift from low-occupancy vehicles.

- (Reference 17 ) - At the average peak-period vehicle occupancy of 1.3 persons/car, the maximum expected passenger volume of a traffic lane is 2600 persons per hour. However, one exclusive bus lane could have a capacity of 60,000 passengers per hour. In New York City, an exclusive bus lane on the I-495 approach to the Lincoln Tunnel carries 25,800 people in the peak hour.

### Status

This measure was combined with the ramp metering measure (#2) early in the process as a single concept for providing preferential treatment for high occupancy vehicles. This measure is included in the plan. The effectiveness and other impacts were described under Measure 2.

## 28. ENCOURAGE THE PEDESTRIAN MODE

### Description

For short trips, walking is frequently the best alternative. Providing amenities such as wider pavements, or moving sidewalks between major activity centers can encourage people to walk for short trips.

### History

The Bay Area Transportation Study Commission conducted a survey in which it was determined that walking accounted for 16% of all trips.[7] However special techniques to enhance the pedestrian mode have never been adopted as an air quality measure in the Bay Area.

### Literature Search

- (Reference 19) - Improving the existing pedestrian circulation system and constructing new facilities -- such as pedestrian overpasses and underpasses, malls, and skywalks -- provide physical conditions conducive to walking by improving pedestrian safety, relieving congestion, reducing pedestrian conflicts with other modes and, in some cases, providing shelter from inclement weather.

  In developing urban areas, communities can ensure that the desired attention is given to pedestrian facilities without increasing public costs by incorporating bonus zoning provisions into the building code. Under these provisions the floor space of a development can be increased -- over the amount permitted by zoning regulations -- by an amount equivalent to the total number of pedestrian improvement "units" included in the development. These improvements include sidewalk widening, multiple building entrances, access to transit or parking garages, subsurface concourse or overhead bridge connections to other buildings or transit facilities, arcades, malls, plazas, offstreat taxi and bus passenger loading areas, off-street truck berths, and midblock connectors. Each improvement has a rated unit value. Bonus zoning has been successfully used to improve the pedestrian environment in New York City's theater district.

- (Reference 13) - A system of pedestrian priority signal/systems in downtown Washington, D.C. would have virtually no air quality benefits.

- (Reference 10) - A pedestrian systems strategy was recommended in this San Diego study. The decrease in trips and VMT would be 0 - 0.1%.

### Effectiveness

A survey of previous studies indicated that, with the exception of auto-free zones, the provision of these amenities would not produce a signif-

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[7] Bay Area Transportation Study Commission, Bay Area Transportation Report, May, 1969.

icant shift from the auto. Rather, it is the dense land use pattern itself which generally encourages pedestrian activity. Since the auto-free zone was already included as a separate measure, the air quality effectiveness of these other pedestrian amenities was judged to be minimal.

Other Impacts

There would be a moderate cost for upgrading pedestrian facilities. A secondary benefit would be the improved social environment.

Status

This measure was dropped in the initial review by the JTS and TAC because of the minimal air quality benefit.

## 29. ENCOURAGE THE BICYCLE MODE

### Description

One strategy which could be particularly effective is the greater use of bicycles for the short utility trip and interface with transit on the commute trip. During the summer and fall months the weather is ideal for cycling, and the daylight is long enough to provide sufficient time for such trips. A comprehensive network of bike lanes would encourage bicycle use.

The two major deterrents to the extensive use of bicycles have been safety and theft. The first, as statistics bear out, could be greatly mitigated through education, acknowledging the bicycle as a legitimate mode and requiring similar knowledge and qualifications for its use as now is required for drivers of cars. Safe parking for bikes, particularly lockers at transit transfer points, shopping centers and other places, is possible with minimal capital outlay ($175 per locker vs. about $5,000 per parking stall or structure) and would do much to stimulate bicycle utility trips.

### History

Bicycles have become popular in recent years. Because of this renewed interest, State and Federal funds are available for bike paths and storage facilities. Many of the cities and couties in the Bay Area have designated systems of bike lanes. However, the emphasis continues to be on providing lanes for recreational use.

### Literature Search

- (Reference 10)- Bicycle systems were recommended in this San Diego plan. A conservative estimate of the effectiveness is that 0.6% of VMT, and 2.3% of trips could be eliminated. An earlier Rand Corporation estimate for this area concluded that, under optimistic conditions, 1.2% of VMT and 4.5% of trips might be reduced.

- (Reference 5) - A number of uses for the bicycle exist which are heavily dependent on the provision of safe bikeways, of other transportation mode transfer coordination, and of adequate bikeway storage facilities. A few examples where emphasis on this nonmotorized mode may provide extensive benefits include: 1) a system designed to provide a feasible mode of access to a local or regional transit system; 2) a system to accommodate the numerous short intrasuburban shopping trips; 3) systems providing for bicycle subscription service in downtown business areas where either autos are banned or where exclusive bikeway access is provided, and; 4) exclusive commuter bikeways via separated rights-of-way or designated roadway use connecting residential areas with employment activity centers.

### Effectiveness

Because the travel model does not include bicycle trips, the potential effectiveness of this measure was estimated from an analysis done as

part of the parking management planning in the Bay Area (Reference 1 ).

The analysis of the estimated potential for bicycle systems was based on an assessment of the bicycle market, i.e. the percentage of people who could potentially substitute a bicycle for their travel needs. The estimation of this market was based on several factors including: trip length, trip purpose, age, occupation, and travel group size. For example, studies indicate that the majority of non-recreational oriented trips are less than 2.5 miles in length. Therefore, trips longer than this were not considered to be divertable to bicycles.

For the analysis, two alternative situations were considered. Alternative 1 assumed that only work trips could be diverted by the provision of bicycle facilities. Alternative 2 assumed that both work and non-work trips (excluding shop trips) could be diverted.

The potential effectiveness of implementing a comprehensive bicycle system summarized in the following table:

| CITY | ALTERNATIVE | REDUCTION TRIPS | REDUCTION VMT |
|---|---|---|---|
| Walnut Creek | 1 | .5% | .2% |
| | 2 | 2.3% | .8% |
| Cupertino | 1 | .4% | .2% |
| | 2 | 1.8% | .6% |
| Petaluma | 1 | .6% | .2% |
| | 2 | 2.8% | 1.0% |
| San Leandro | 1 | .5% | .7% |
| | 2 | 1.8% | 1.1% |
| Vallejo | 1 | 1.0% | .5% |
| | 2 | 3.4% | 1.7% |

In applying this analysis to the region as a whole, the most conservative estimates under Alternative 2 (both work and non-work trips diverted) were selected from the table. Accordingly it was estimated that 1.8% of trips could be diverted, and 0.6% of VMT. This translates to an 1985 air quality benefit of 2.0 tons daily of HC, 31.9 tons of CO, and 1.2 tons of $NO_x$.

Other Impacts

This measure could save 22,000 gallons of gasoline per day by 1985.

Moderate capital costs would be associated with providing bicycle lanes and storage facilities. It is assumed that separate right-of-way would not be required.

An increase in the number of accidents may occur. However, health benefits because of the increased exercise are also likely.

This measure has generally found wide public acceptance.

Status

Staff recommended that this measure be included in the plan. The EMTF and MTC concurred. A specific plan must now be developed with local jurisdictions to identify and implement the specific measures which would facilitate the bicycle mode.

## 30. TOLL REDUCTION FOR CARPOOLS

### Description

One means of encouraging carpools is tc offer a cost incentive. Eliminating the tolls on bridges and on other toll facilities could accomplish this.

### History

Carpool tolls were eliminated on the Bay Bridge in 1975. It is estimated that 2200 carpools use the priority lane during the morning peak. The Golden Gate Bridge District began allowing carpools to use the bridge toll-free in 1976. Approximately 1100 carpools use this lane. The San Mateo and Dumbarton beidges also provide free passage to carpools.

### Literature Search

- (Reference 19) - Lower tolls for carpools entering downtown areas have about the same effect as reduced parking charges in inducing auto occupancy increases.
- (Reference 18) - Preferential treatment at toll collection points can be accorded to high-occupancy vehicles by (1) permitting nonstop passage through toll stations or (2) instituting differential tolls that favor high-occupancy vehicles. Generally, these toll policies enhance the attractiveness of group travel by offering economic incentives to users of high-occupancy vehicles. The first alternative also offers the added advantage of travel time savings. But, combining preferential treatment at toll stations with other preferential treatments can provide an even stronger incentive to shift to high-occupancy modes.

### Effectiveness

This measure is already in place on most bridges during the peak periods. Staff estimated that extension of the measure to off-peak periods would lead to the formation of a very small number of new carpools. Thus the air quality benefits are expected to be minimal.

### Other Impacts

A small loss in toll bridge revenue would result.

### Status

Staff did not recommend this measure for inclusion in the plan because the potential air quality benefits of wider application of this measure are minimal.

## 31. PREFERENTIAL PARKING FOR CARPOOLS

### Description

Special lots would be reserved for carpools which would offer an advantage in location and/or price. These might be at large employee parking lots, transit park-and-ride lots, or in downtown areas.

### History

Preferential parking for carpools is provided at some BART stations. CalTrans leases state lots in San Francisco which are available to carpools for no more than $10/month.

EPA promulgated a number of parking regulations in its TCP. These would have exempted carpools from the employee parking fee, and provided that close-in parking be allocated to carpools.

### Literature Search

- (Reference 19) - Programs which give carpools preferential parking rates are particularly effective in obtaining large increases in the number of carpools and in average auto occupancy, most notabley in downtown areas and high density employment centers where parking supply is limited. Typically these programs are tied in with carpool matching services. Some companies that instituted parking incentives obtained a doubling in the number of carpools. The resultant proportion of auto commuters in carpools exceeded 50 percent in specific cases.

- (Reference 1 ) - This study estimated that if all employee lots which provided at least 300 spaces designated priority parking for carpoolers, vehicle work trips could be reduced by 0.4 - 0.8% and work trip VMT by 0.8 - 2.0%. Synergistic effects could occur if this were implemented with related measures.

- (Reference 13) - This Washington, D.C. study forecast a 1.09% decrease in vehicle work trips if the most accessible spaces in parking garages and lots were reserved for carpools.

### Effectiveness

The travel model was used to analyse this measure. Two tests were run. The first involved a 5 minute terminal time increase for single-occupant autos, which meant carpools had a time advantage. Vehicle work trips were estimated to decline by 6% while carpools increased by 18%. The second test reduced the carpool parking cost to zero. In this case, CBD-bound vehicle work trips decreased by 2%, with carpools increasing by 9%. The results of the second test were used as a conservative estimate of the effectiveness. This would reduce HC by 0.1 tons, CO by 1.5 tons, and $NO_x$ less than 0.1 tons/day in 1985.

### Other Impacts

Implementation time for this measure would be relatively short. A modest subsidy would be needed to fund the cost incentive aspect of the program.

Traffic congestion during peak periods would be alleviated. Substantial fuel savings would also be realized.

Status

Upon staff's recommendation, the EMTF and MTC included this measure in the plan. Implementation details are being prepared.

## 32. CARPOOL MATCHING INFORMATION

### Description

These programs are oriented to providing assistance to those individuals interested in forming carpools. Specifically, this measure would expand the current computer matching program to include secondary employment centers and to solicit employer participation.

### History

A computer matching carpool program called RIDES began in the Bay Area in 1973. The program is administered by CalTrans, but has the cooperation of a number of public and private agencies. A survey conducted in 1975 indicated that approximately 5000 persons had formed carpools as a result of this program. Santa Clara County has also started a carpool matching program.

The EPA TCP specified that a computer matching program be set up, that employer participation be solicited, and that pilot programs be set up at major military installations in the region. The MTC TCP also called for an expanded RIDES program.

A "Casual carpool" program for Marin County is underway, partially funded by MTC.

### Literature Search

- (Reference 10) - This San Diego study estimated that a major employer carpool program could reduce vehicle trips and VMT by 0.5 - 2.5%. Only very minor legal and institutional problems were identified.

- (Reference 13 ) - This study estimated that a regional and localized carpool matching service in the Washington, D.C. area will reduce vehicle work trips by 1% and increase auto occupancy by 2.2%. However, transit ridership was expected to decline by 3.9%.

- (Reference 19 ) - Employer matching programs appear to be the most effective, with a carpooling increase of about 75% on the average. Areawide matching programs are much less effective. A better strategy would be regional assistance to employer programs.

### Effectiveness

The implementation of this measure was assumed to be through a non-profit corporation that was set up to handle the carpool matching and vanpool programs. Campaigns were targeted toward specific employers and the program staff estimated that 50,000 additional carpools would be formed by 1985. On the order of 2,000 additional vanpools would be formed. Together, these would reduce vehicle work trips by 3.9%, leading to a reduction in HC emissions of 1.7 tons/day, CO by 20.4 tons/day, and $NO_x$ by 1.2 tons/day in 1985.

Other Impacts

There are moderate administration costs associated with this program.

Participants in the ride sharing programs would enjoy a reduction in their travel expenses. It is possible that if enough persons participate in the program, it may reduce parking revenues for cities and private parking lot operators in the larger CBD's.

This measure may conserve 44,000 gallons/day by 1985

Status

Staff recommended that the carpool matching and vanpooling measures be combined as a rider-sharing measure and included in the plan. The EMTF and MTC concurred.

A non-profit corporation has been formed to implement this expanded ride-sharing concept. It is responsible for organizing the leasing of vans and will also take over the existing carpool matching and data services currently provided by CalTrans. The initial funding sources include the State Energy Commission, CalTrans District 04, and MTC. The Board of Directors is nominated by MTC, the Federal Highways Administration, the Bay Area Council, the California State Automobile Association, and CalTrans.

## 33. ASSIST VANPOOL FORMATION

### Description

Vanpooling has potential for replacing cars on the longer commute trips. The passengers pay the capital and operating costs of the van, and the driver is responsible for the operating and administrative aspects. A public entity can assist by matching interested participants, and by facilitating the lease and insurance of the equipment.

### History

The Golden Gate Bridge, Highway and Transportation District has a demonstration program to initiate vanpools from Marin County. It is a program for commuters to use Golden Gate vans for a six months trial, and then the District will assist them in securing their own van. The RIDES corporation has also begun a vanpool program, in which the vans are actually leased to the commuter groups.

### Literature Search

- (Reference 19) - Vanpooling is a fairly new concept, so experience is still quite limited. The concept has apparently proved popular where applied. Initial indications are that at least 10 percent and sometimes one fourth or more of all employees at suburban sites can be induced to vanpool when work schedules are fairly regular.

- (Reference 16) - A cost computation suggests that for vanpools to be economically viable the one-way trip needs to be on the order of 25 miles for costs similar to the out-of-pocket costs of operating an automobile. Since the percentage of the employees of any single firm who would live this far from work is relatively small, a very large employee pool is necessary to achieve even a single vanpool. Recent experience in California suggests that 3000 employees is about the minimum size firm that is necessary in a large metropolitan area to have any real chance of implementing breakeven vanpool operations at an income of 3 cents per passenger miles.

  One means of alleviating this constraint is to broaden the base of potential vanpoolers by including employees from a number of firms. A public agency can encourage this by operating a matching service and assisting in the equipment lease, insurance, and other items.

### Status

This measure was combined with carpool matching into an overall ride-sharing program, because a non-profit corporation has already been set up to handle these programs. The effectiveness and impacts of the overall measure, which was included in the plan, are described under measure #32, Carpool Matching.

## SECTION 108(f) MEASURES

Eighteen transportation control measures were listed in Section 108(f) of the Clean Air Act Amendments as being "reasonably available". As mentioned at the beginning of this report, our analysis was well underway when the Clean Air Act was amended, and therefore did not follow the format of the 18 measures. Accordingly, in this section, each of the 18 measures is listed and a reference is made to the appropriate control measure(s) considered in the AQMP and described in the previous section. In certain cases, the measure may have been analyzed in another area of the Air Quality Maintenance Plan and it would be so noted.

(i) motor vehicle emission inspection and maintenance programs;

This measure was analyzed as part of the "Mobile Source Control Measures" and is included in the Plan.

(ii) programs to control vapor emissions from fuel transfer and storage operations and operations using solvents;

This measure has already been implemented by the Bay Area Air Quality Management District (BAAQMD). Tightening of these controls were studied as part of the "Stationary Source Control Measures" and these are included in the Plan.

(iii) programs for improved public transit;

Measure # 24 Additional Transit Service
25 Transit Fare Reductions
26 Improved Transit Comfort
27 Bus and Carpool Lanes

(iv) programs to establish exclusive bus and carpool lanes and areawide carpool programs;

Measure # 27 Bus and Carpool Lanes
32 Carpool Matching Information
33 Assist Vanpool Formation

(v) programs to limit portions of road surfaces or certain sections of the metropolitan areas to the use of common carriers, both as to time and place;

Measure # 13 Auto Free Zones
27 Bus and Carpool Lanes

(vi) programs to reduce emissions by improvements involving new transportation policies and transportation facilities or major changes in existing facilities;

MTC, in cooperation with other agencies, defines plans for long range transit improvements. The air quality impacts of these proposals are analyzed. Some current examples of such studies are the Santa Clara Valley Corridor Study, the Peninsula Transit Alternatives Project, and the BART extension studies.

These projects were not analyzed as part of the AQMP because of their long term nature; the transportation controls in the AQMP were selected because they could be implemented relatively soon, and thus could aid in attainment of the standards. For long term maintenance, a compact land use scenario was analyzed. Future development was concentrated along major transit corridors. A significant decrease in the rate of automobile travel growth was forecast. However, this alternative was dropped when the public review indicated that there was serious opposition to this measure.

(vii) programs to control on-street parking;

Measure # 9 Better Enforcement of Parking Regulations
10 Limit Number of Parking Spaces
11 Prohibit On-Street Parking During Peak Hours

(viii) programs to construct new parking facilities and operate existing parking facilities for the purpose of park and ride lots and fringe parking;

Measure # 31 Preferential Parking for Carpools

(ix) programs to limit portions of road surfaces or certain sections of the metropolitan area to the use of non-motorized vehicles or pedestrian use, both as to time and place;

Measure # 12 Area License
13 Auto-Free Zones

(x) provisions for employer participation in programs to encourage carpooling, vanpooling, mass transit, bicycling, and walking;

Measure # 28 Encourage Pedestrian Mode
29 Encourage Bicycle Mode
31 Preferential Parking for Carpools
32 Carpool Matching Information
33 Assist Vanpool Formation

(xi) programs for secure bicycle storage facilities and other facilities, including bicycle lanes, for the convenience and protection of bicyclists, in both public and private areas;

Measure # 29 Encourage Bicycle Mode

(xii) programs of staggered hours of work;

Measure # 5 Staggered Work Hours
6 Four-Day Work Week

(xiii) programs to institute road user charges, tolls or differential rates to discourage single occupancy automobile trips;

Measure # 15 Road Pricing Techniques
16 Increased Parking Costs
20 Increased Tolls

(xiv) programs to control extended idling of vehicles;

Measure # 1 Computerized Traffic Flow
3 Traffic Engineering Improvements
4 Truck Regulations
23 Goods Movement Consolidation

(xv) programs to reduce emissions by improvements in traffic flow;

Measure # 1 Computerized Traffic Flow
2 Ramp Metering
3 Traffic Engineering Improvements
4 Truck Regulations

(xvi) programs for the conversion of fleet vehicles to cleaner engines or fuels, or to otherwise control fleet vehicle operations;

Promoting the use of new or modified fuels and promoting the use of alternative power sources were studied under "Mobile Source Control Measures". They were not put into the AQMP because the AQMP-Joint Technical Staff felt that these two measures would come about as a result of more stringent emission standards and were, therefore, repetitive.

Controlling fleet vehicle operations was covered under:

Measure # 4 Truck Regulations
23 Goods Movement Consolidation

(xvii) programs for retrofit of emission devices or controls on vehicle and engines, other than light duty vehicles, not subject to regulations under section 7521 of subchapter II of this chapter;

This measure was analyzed as part of the "Mobile Source Control Measures" and included in the Plan.

(xviii) programs to reduce motor vehicle emissions which are caused by extreme cold start conditions;

This measure was not considered applicable to the Bay Area because the expected minimum temperature ranges from 44$^{o}$ near the Bay to 32$^{o}$ in the Diablo VAlley.

## REFERENCES USED IN SECTION G


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# Section-H

# CONTROL STRATEGY ANALYSIS FOR PHOTOCHEMICAL OXIDANT

The effectiveness of alternative control strategies in improving air quality was analyzed by using a series of computer-based models. Given the wide variety of human activities causing air pollution, projections of future air quality improvements must account for changes in these activities and in future air pollution control technologies. The models used are simply means of quantifying the effects of such changes on future air quality.

The forecasting system consists of four components:

- The ABAG Series 3 population, housing, employment and land use modeling system.
- The MTC travel demand models.
- The ABAG vehicle emissions model.
- The Livermore Regional Air Quality Model (LIRAQ) maintained by the BAAQMD.

These models were used in three distinct applications. First they were used to project future air quality assuming a continuation of existing regional growth trends and existing control programs. The results of this "baseline" projection were previously described.

Second, using the baseline projections as a starting point, an emissions sensitivity analysis was conducted to determine the range of emissions levels necessary to meet the federal oxidant standard. The purpose of this exercise was to provide information on the design of control strategies to meet the standard.

Third, a series of strategy cases were developed from the alternative control measures and tested through the modeling system for their effectiveness in improving air quality.

## DETERMINING THE RANGE OF EMISSION REDUCTIONS NECESSARY TO MEET THE OXIDANT STANDARD

To define the emission reductions needed to meet the oxidant standard, the baseline emission levels were systematically reduced and analyzed by the LIRAQ model. (The testing of such emission changes is sometimes referred to as sensitivity analysis.) Thus the model was applied in successive iterations using a number of differing hydrocarbon and $NO_x$ emissions assumptions until the emissions levels which will result in attainment of the standard were found. Additional analysis and example LIRAQ maps produced as part of this analysis can be found in Section N.

Table 21 summarizes the results of the sensitivity analysis. Each column of the table corresponds to a different combination of percent reductions in hydrocarbon and $NO_x$ emissions. The sensitivity analysis was conducted using the 1985 baseline emissions as the starting point, indicated in the first column with zero emission reductions. The expected worst case regionwide high hour oxidant level for each set of emission levels is shown in the last row.

From the table, it is apparent that in order to meet the .08 ppm Federal oxidant standard, more than a 40 percent reduction in regionwide hydrocarbon emissions is required in 1985. A closer examination of the results indicates that a 43% reduction in hydrocarbon emissions is required. This translates to an allowable level of hydrocarbon emissions of 450 tons per day to attain the 0.08 ppm Federal oxidant standard.

A second conclusion apparent from the table is that reducing oxides of nitrogen emissions results in higher oxidant levels than what would occur with hydrocarbon emission reductions alone. Laboratory studies of oxidant formation and empirical evidence from Los Angeles and elsewhere indicate that nitric oxide reacts to temporarily suppress ozone formation--the ozone formation is delayed. This means that the level of nitrogen oxides plays an important role in determining where and when the maximum ozone formation will occur. Table 22 summarizes what is known and what is suspected in regard to the effects of further control of $NO_x$ emissions in the Bay Area. The LIRAQ sensitivity analysis indicates that further $NO_x$ control will result in higher oxidant levels within the region than would occur with a "hydrocarbon only" control strategy. On the other hand, by not controlling nitrogen oxides, it is suspected that the oxidant problem of the Bay Area may be transported to a neighboring airshed (e.g., Sacramento or Monterey). The implications to be drawn are that hydrocarbons should be stringently controlled and that care should be exercised in deciding how much control of oxides of nitrogen emissions is appropriate.

Table 21. LIRAQ Emission Sensitivity Analysis Results

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| % Reduction HC | 0 | 20 | 40 | 60 | 80 | 40 | 80 |
| % Reduction NO | 0 | 0 | 0 | 0 | 0 | 20 | 40 |
| Expected worst-case regionwide high hour ozone (ppm) | .19 | .14 | .08* | .07 | .06 | .11 | .06 |

*This value was rounded off from an original value of .0846 ppm.

Assumptions: 1) 1985 Baseline Emission Inventory
2) July 26, 1973 Prototype Meteorology

TABLE 22. Summary of Oxides of Nitrogen ($NO_x$) Control Issue

| THE IMPACTS OF ADDITIONAL $NO_x$ CONTROLS | | THE IMPACTS OF NO ADDITIONAL $NO_x$ CONTROLS | |
|---|---|---|---|
| OXIDANT AIR QUALITY | | OXIDANT AIR QUALITY | |
| Within the Bay Area | Outside the Bay Area | Within the Bay Area | Outside the Bay Area |
| LIRAQ analysis indicates that higher levels of oxidant occur with $NO_x$ controls in the proposed comprehensive strategy. | It is suspected that downwind areas where transport may contribute to existing oxidant problems would be improved. | LIRAQ analysis indicates that lower levels of oxidant occur with no $NO_x$ controls in the proposed comprehensive strategy. | It is suspected that downwind areas where transport may contribute to existing problems would experience worse oxidant air quality. |
| NITROGEN DIOXIDE ($NO_2$) AIR QUALITY | | NITROGEN DIOXIDE ($NO_2$) AIR QUALITY | |
| Within the Bay Area | Outside the Bay Area | Within the Bay Area | Outside the Bay Area |
| May reduce $NO_2$ violations if appropriate controls can be identified, e.g., stationary vs. mobile and ground level vs. elevated emissions. | Not of concern (no $NO_2$ violations are recorded in neighboring air basins). | $NO_x$ emissions are projected to be relatively constant between 1975-2000. However, the relative contributions from mobile sources and industry change substantially. $NO_2$ violations may decrease as the motor vehicle $NO_x$ emissions decrease by 2000. | Not of concern (no $NO_2$ violations are recorded in neighboring air basins). |

## Total versus Reactive Hydrocarbons

A subject of controversy over the years has been whether to control total hydrocarbons or to selectively reduce the more reactive classes of hydrocarbons. The figures in the emission inventory are total, non-methane organics. For the purpose of a photochemical model, however, it was necessary to estimate a breakdown into reactivity classes so that reaction rate constants could be reasonably applied. This was done for the LIRAQ photochemistry.

The reduction in hydrocarbons used for control strategy testing assumed a uniform reduction in all reactivity classes in the baseline emission inventory. This assumption was a reasonable one for two reasons: (1) EPA has recommended the total hydrocarbon approach rather than the selective reduction or substitution approach; (2) data was not available on relative hydrocarbon reactivity changes after imposing the many different control strategies recommended in the plan. Even if such data were available, recent studies suggest that a control strategy based on different reactivities would be questionable at best.

## SUMMARY OF THE CONTROL STRATEGIES TESTED

Three control strategies were developed and tested with the modeling system. Each of these strategies were tested for their short term (1985) and long term (2000) effectiveness. The strategies are composed of alternative control measures considered to be the most effective and implementable. These strategies are summarized in Table 23.

Figure 23 summarizes how the land use, transportation, and technological emission controls were input to the modeling system previously described. From the inventory of alternative control measures, short and long term technological improvements were developed and their effects in reducing stationary and mobile source emissions computed. Similarly, the effects of land use and transportation control measures were analyzed directly by the ABAG and MTC models. These changes in the ABAG and MTC models were then translated into emission changes. Emission inventories were reconstructed based on the control measures and the resulting air quality projected by LIRAQ. The short and long term comprehensive strategies were evaluated by making appropriate modifications to each of the models in the system as shown.

The main results of the strategy analysis are summarized in Table 24. The table indicates that substantial improvements in air quality can be made through the use of technology. It also indicates that technology alone will not be sufficient to meet the .08 ppm Federal oxidant standard. The transportation and land use management strategy, although relatively ineffective in the short term, is shown to become increasingly effective with time. The primary value of the transportation and land use management strategy is that it helps in maintaining the air quality improvements achieved through the application of technology. Under the maximum technology strategy, air quality deteriorates significantly between 1985 and 2000 despite technological advances. The comprehensive strategy reduces this deterioration, but is still not enough to meet the Federal oxidant standard.

Table 23. Summary of Control Strategies Tested

| MAXIMUM TECHNOLOGY STRATEGY | TRANSPORTATION AND LAND USE MANAGEMENT STRATEGY | COMPREHENSIVE STRATEGY |
|---|---|---|
| • Use paints and other coatings that are water based and/or have a high solids content.<br><br>• Use closed systems for storage and transfer of organic liquids.<br><br>• Use best available control technology (BACT) on new and existing sources of hydrocarbon emissions.<br><br>• Adopt more stringent vehicle (light & heavy duty) exhaust emission standards.<br><br>• Implement mandatory annual inspection and maintenance program for light and heavy duty vehicles.<br><br>• Require exhaust control devices on existing heavy duty gasoline trucks. | • Increase tolls on bridges.<br><br>• Implement regional parking strategy to discourage private auto use and encourage high-occupancy auto use<br>- parking tax<br>- preferential parking for carpools, vanpools<br><br>• Provide additional transit service.<br><br>• Increase bus/carpool lanes and ramp metering.<br><br>• Implement an auto control zone in San Francisco central business district to reduce traffic.<br><br>• Provide more ride sharing services such as jitneys and vanpools.<br><br>• Develop more extensive bicycle systems.<br><br>• Achieve more compact development throughout the region by the year 2000. | • By 1985, the comprehensive strategy includes: all of the technological control measures except for more stringent vehicle exhaust emission standards; and all of the land use/transportation measures. The effects of compact development were not included in the analysis for 1985 since the short time frame was insufficient for achieving significant results.<br><br>• By 2000, the comprehensive strategy includes: all of the technological control measures except for the exhaust control devices on existing heavy duty gasoline trucks (this measure provides short term benefits only); and all of the land use/transportation measures. |

Figure 23

**Control strategy testing with the AQMP Modeling System**

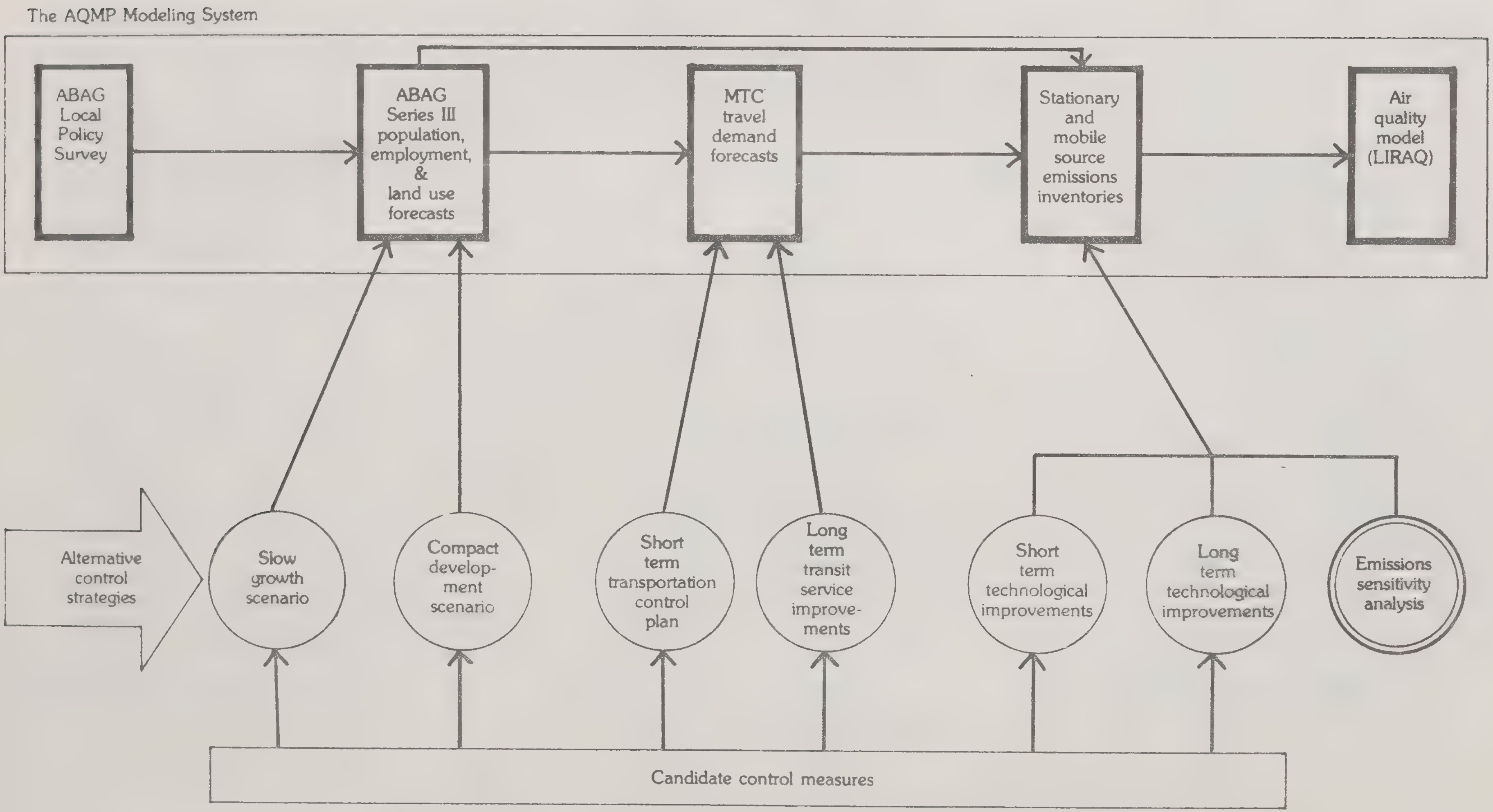


Table 24. Effectiveness of Alternative Control Strategies

| Strategy | 1985 | | | 2000 | | |
|---|---|---|---|---|---|---|
| | Hydrocarbon Emission Reduction Potential | Estimated Regionwide High Hour Oxidant Level (ppm) | Estimated No. of Annual Violations of the 1-Hour .08 ppm Federal Oxidant Standard | Hydrocarbon Emission Reduction Potential | Estimated Regionwide High Hour Oxidant Level (ppm) | Estimated No. of Annual Violations of the 1-Hour .08 ppm Federal Oxidant Standard |
| Baseline (do-nothing)* | (797 tons/day) emitted | .19ppm | 130 | (1,058 tons/day) emitted | .24ppm | 275 hours |
| Maximum Technology | - 280 tons/day | .10ppm | 3 | - 441 tons/day | .13ppm | 16 hours |
| Transportation and Land Use Management | - 7 tons/day | not estimated | - | - 84 tons/day with slow growth | .23ppm | 220 hours |
| Comprehensive Strategy* | - 286 tons/day | .10ppm | 3 | - 513 tons/day with slow growth | .12ppm | 11 hours |

*Does not assume New Source Review Regulation.

As previously discussed, the Federal oxidant standard is a one hour standard, not to be exceeded more than once per year. Table 24 indicates that if a comprehensive strategy is implemented, the number of times the standard would be exceeded drops to approximately 3 in 1985 and 11 in the year 2000. These estimates are necessarily approximate due to the natural variation in meteorological conditions from year to year. The California standard for oxidants, at .10 ppm for one hour, would be met in 1985 under a comprehensive strategy, but would be violated in the year 2000. Figures 24-30 are examples of LIRAQ results for each of the strategy cases summarized in Table 24.

An additional analysis was conducted to test the effects of a comprehensive strategy on the three northernmost counties in the region--Napa, Sonoma, and Solano. A comparison of expected oxidant levels on the LIRAQ prototype day in these counties is presented in Table 25 for both baseline conditions and under a comprehensive strategy. The table clearly shows a substantial improvement in oxidant levels will occur in these northern counties under a comprehensive strategy. Based on the worst case estimates and number of expected violations for the region previously summarized in Table 18, it is expected that the oxidant standard will also be met in the northern counties under a comprehensive strategy.

## MEETING THE .08 PPM OXIDANT STANDARD

The amount of hydrocarbon emissions allowable for the Bay Area to meet the oxidant standard is variable and influenced by a number of factors. As previously noted, the level of nitrogen oxides present strongly influences peak oxidant formation. Similarly, the spatial and temporal distribution of emissions is important. Based on the best information available, hydrocarbon emissions of less than 450 tons per day are required to meet the 0.08 ppm oxidant standard. In some instances, depending on nitrogen oxides present and how the hydrocarbons are distributed, substantially less hydrocarbon emissions would be needed in order to meet the standard.

The additional reductions in hydrocarbon emissions required to meet the oxidant standard in 1985 and 2000 are summarized in Table 26. By comparing the hydrocarbon emissions remaining after implementation of a comprehensive strategy to the allowable emissions level, the additional increments of emission reduction necessary to meet the standard may be estimated as shown in the table. Two estimates are given for the year 2000 to indicate the range of the additional reductions required depending on the population level reached in the region at that time.

Three alternatives have been identified for designing a strategy to meet the .08ppm oxidant standard:

1) Implement additional, less cost-effective controls on existing hydrocarbon sources.

Table 25. LIRAQ Baseline and Comprehensive Strategy Analysis for the North Bay (2000)

| | Baseline | Comprehensive Strategy |
|---|---|---|
| Location of North Regional High Hour Ozone | 12 km. ESE Travis AFB | 14 km. ESE Travis AFB |
| North Regional High Hour (ppm) | .08 | .06 |
| Monitoring Station with Highest Ozone | Napa Airport | Travis AFB |
| Ozone at Highest Station (ppm) | .07 | .06 |
| Projected Ozone Maximum at Individual Stations (ppm) | | |
| San Francisco | .02 | .02 |
| Santa Rosa | .04 | .04 |
| San Rafael | .03 | .03 |
| Petaluma | .04 | .03 |
| Napa | .07 | .05 |
| Sonoma County Airport | .03 | .03 |
| Pittsburg | .05 | .05 |
| Hamilton Air Force Base | .03 | .03 |
| Napa County Airport | .07 | .05 |
| Concord | .06 | .04 |
| Richmond | .04 | .03 |
| Travis Air Force Base | .07 | .06 |
| Angel Island | .04 | .03 |
| Point Bonita | .04 | .03 |
| Fairfield | .06 | .05 |

2) Enforce restrictions on the growth of new sources and indirect sources of hydrocarbon emissions in the region.

3) Some combination of 1 and 2.

Table 26. Hydrocarbon Emission Reductions Required to Achieve the 0.08 PPM Photochemical Oxidant Standard

| | 1985 (Tons/Day) | 2000 (Tons/Day) | |
|---|---|---|---|
| Base Line Emissions | 797 | 1058 | |
| Allowable Hydrocarbon Emissions[a] | <450 | <450 | |
| Hydrocarbons Remaining After Implementing Comprehensive Strategy | 511 | 604[b] | 545[c] |
| Additional Hydrocarbon Reductions Needed to Meet Standard | >61 | >154[b] | >95[c] |

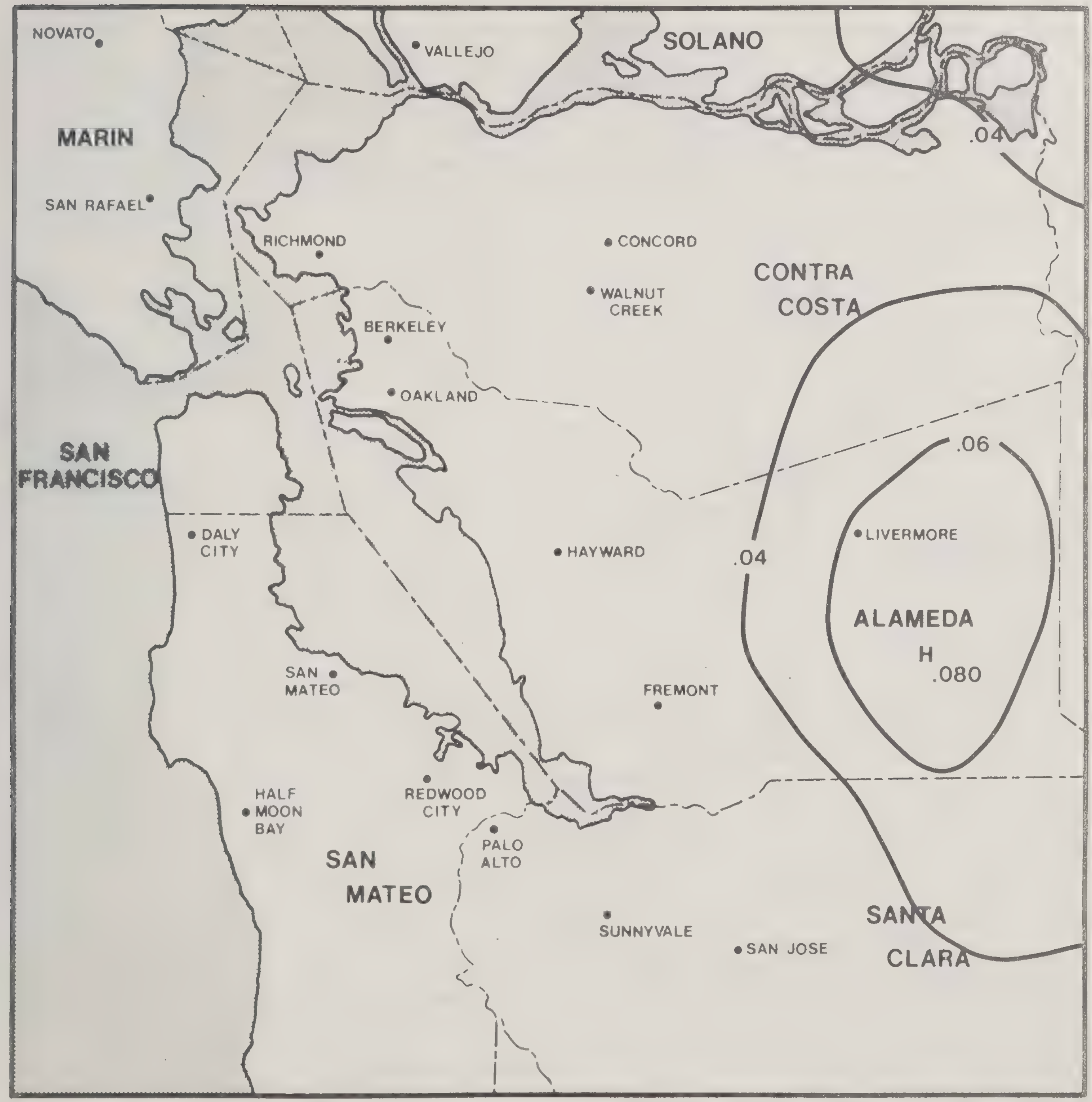
[a]Varies as a function of oxides of nitrogen emissions and the spatial and temporal distribution of all precursor emissions.

[b]Assumes upper range of population forecast in Series 3 projections--6.1 million people in 2000.

[c]Assumes lower range of population forecast in Series 3 projections-- 5.4 million people in 2000.

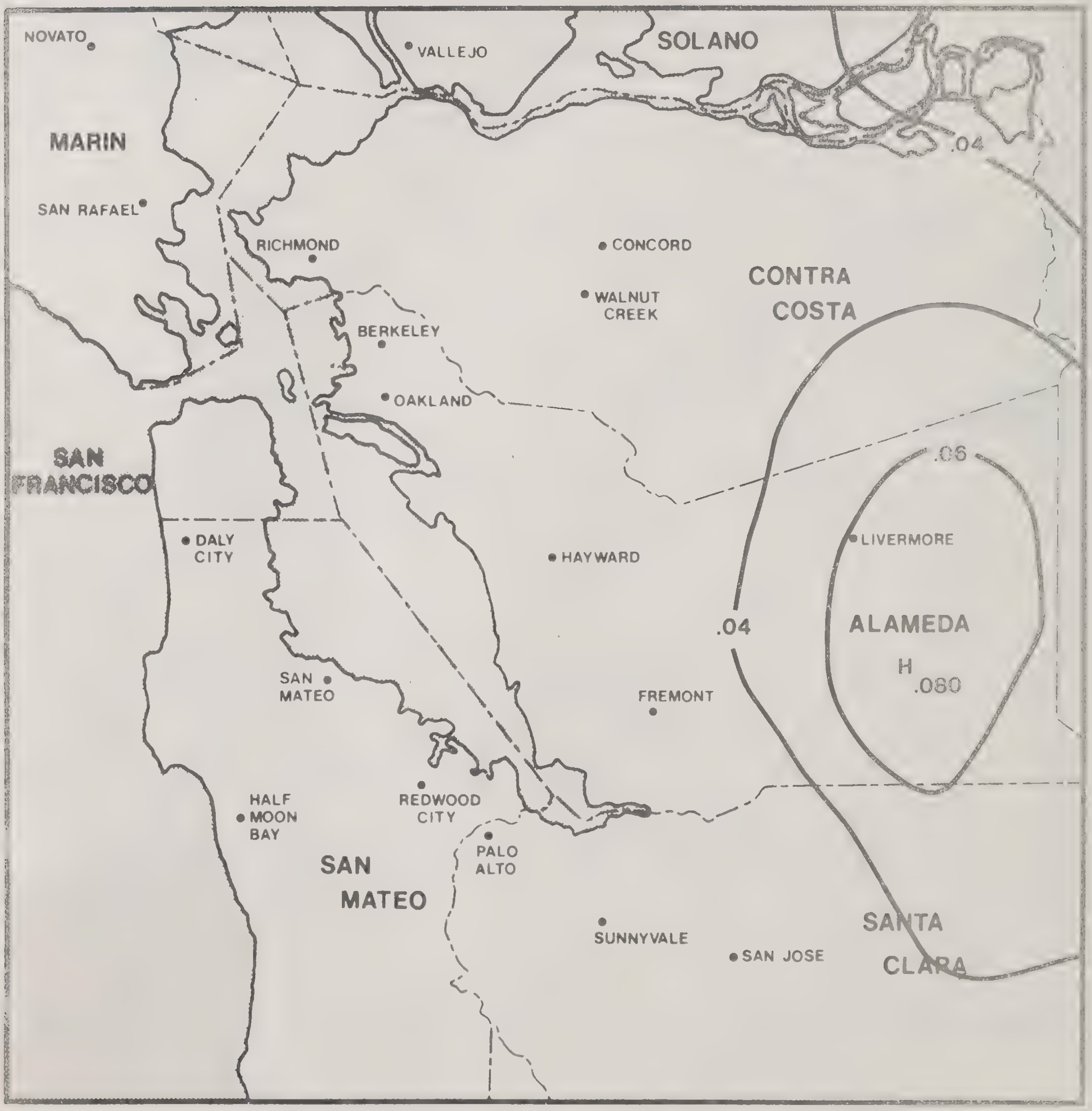
Figure 24. Example LIRAQ Results - 1985 Control Strategy Analysis

(Maximum Technological Improvements Only)



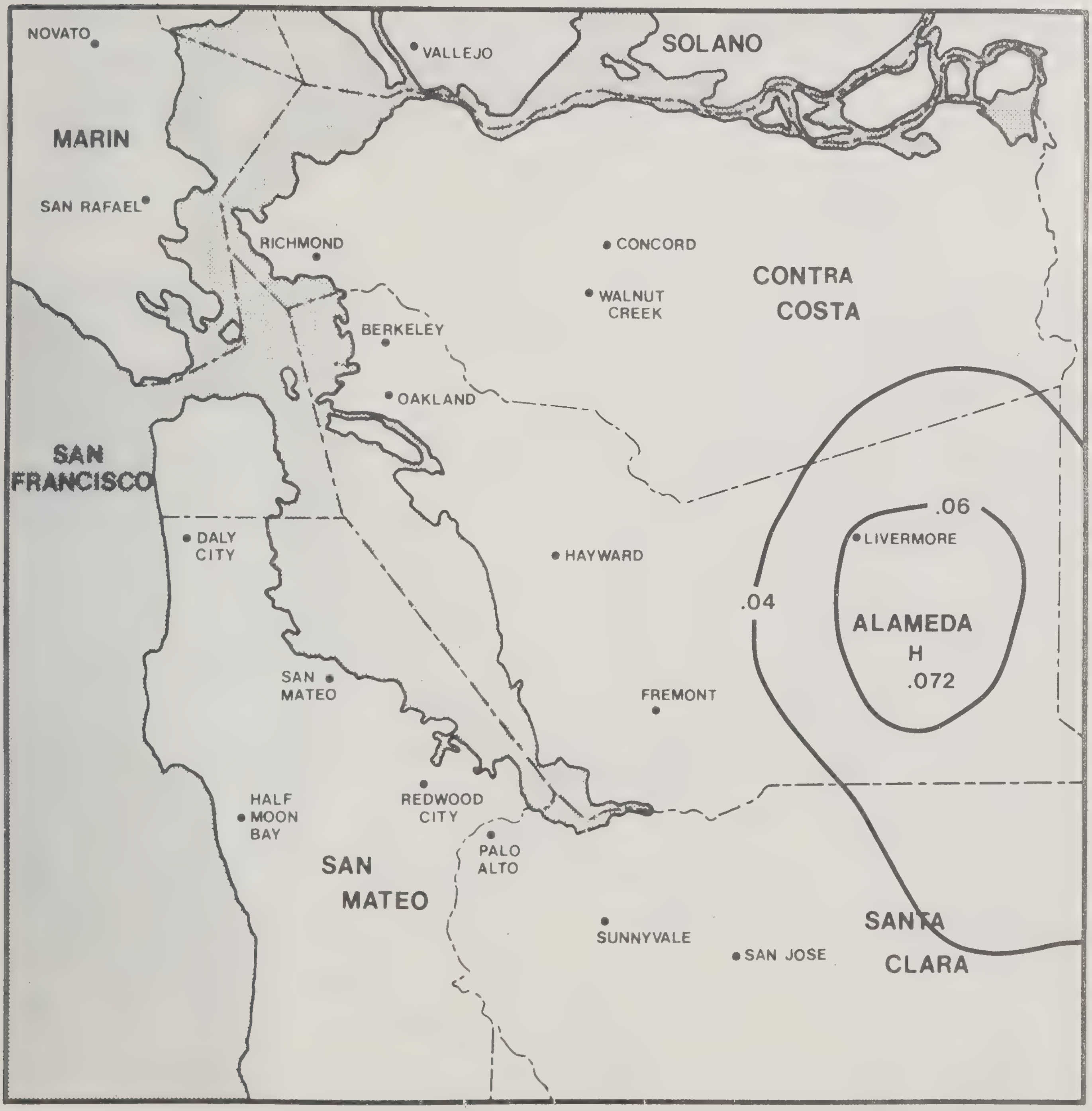

Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 1985 baseline inventory

Figure 25. Example LIRAQ Results - 1985 Control Strategy Analysis (Comprehensive Strategy including Additional NOx Controls)



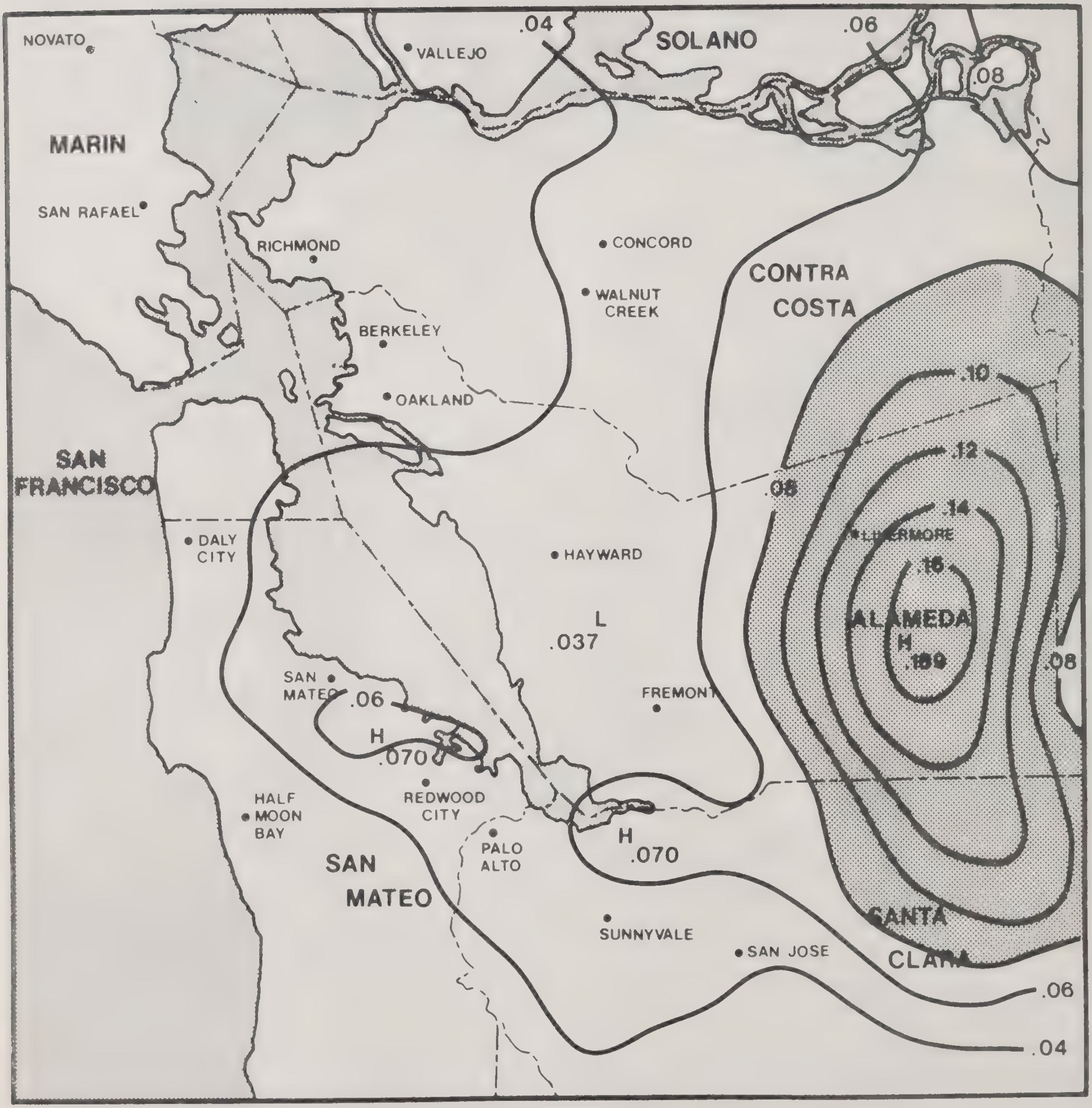

Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 1985 baseline inventory

Figure 26. Example LIRAQ Results - 1985 Control Strategy Analysis (Comprehensive Strategy without Additional NOx Controls)




Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 1985 inventory

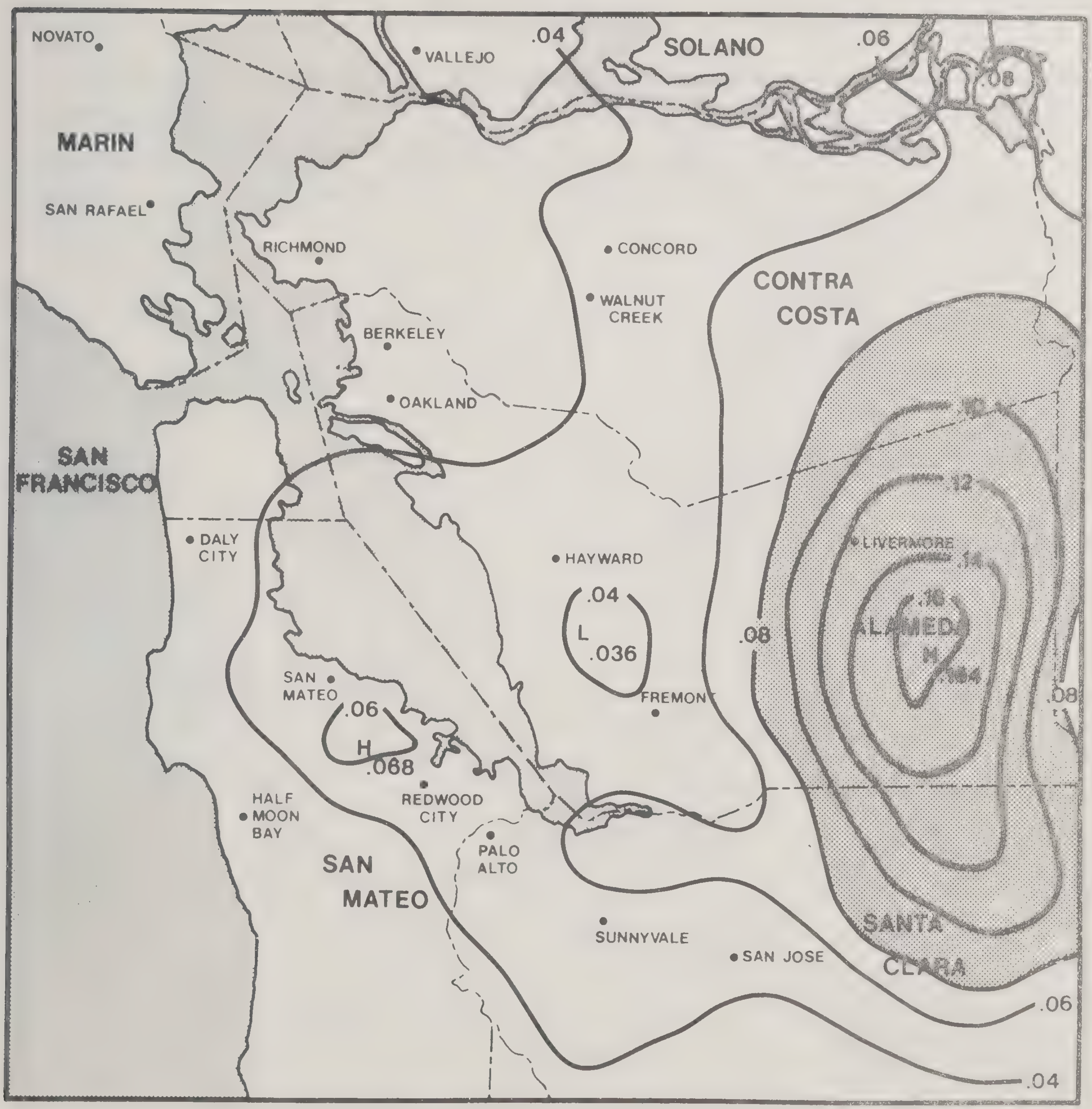
Figure 27. Example LIRAQ Results - 2000 Control Strategy Analysis (Baseline Projection Assuming Slower Population Growth Rate)




Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 2000 baseline inventory

Figure 28. Example LIRAQ Results - 2000 Control Strategy Analysis

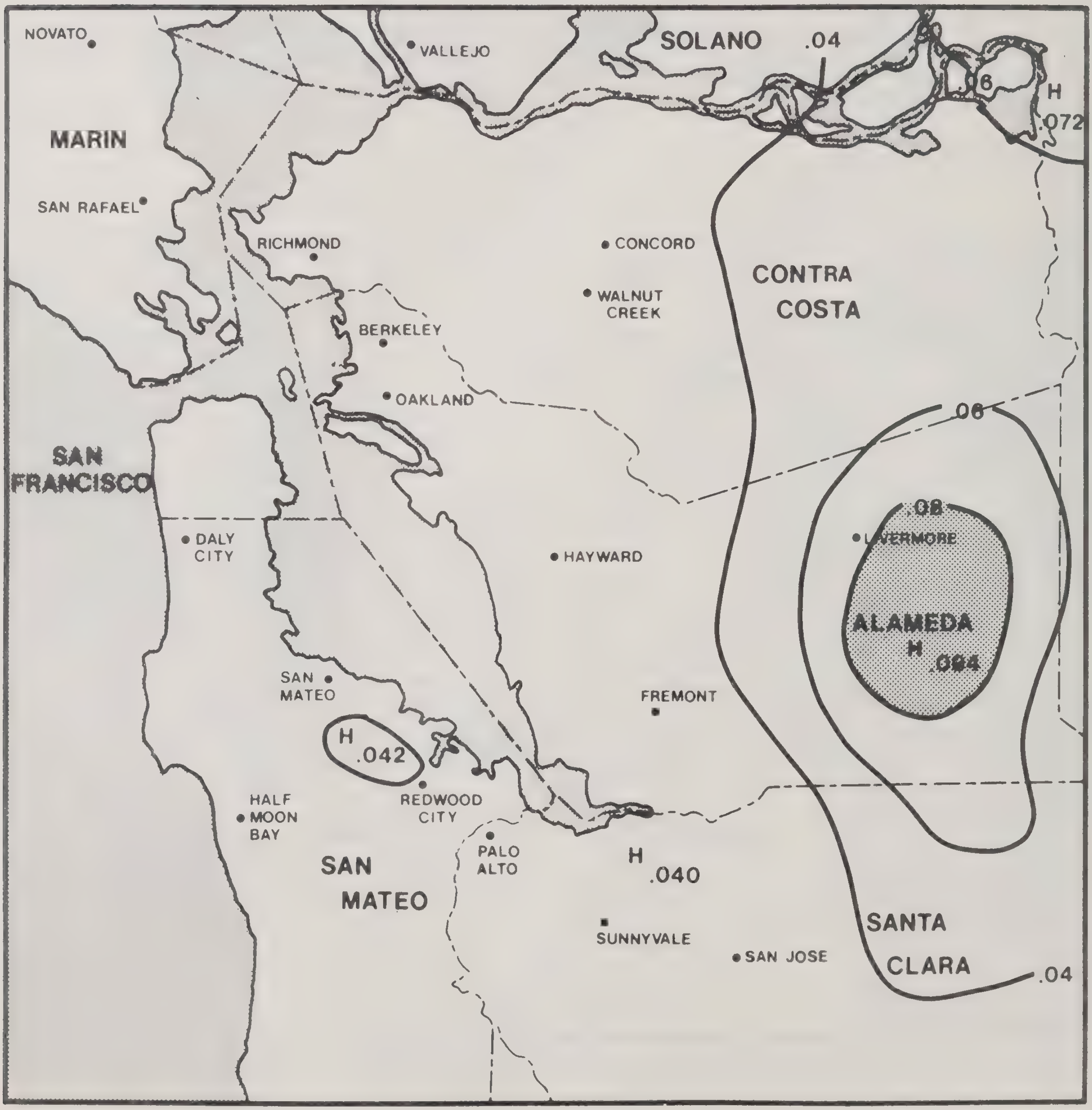
(Transportation Controls and Land Use Management Only)




Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 2000 baseline inventory

Figure 29. Example LIRAQ Results - 2000 Control Strategy Analysis

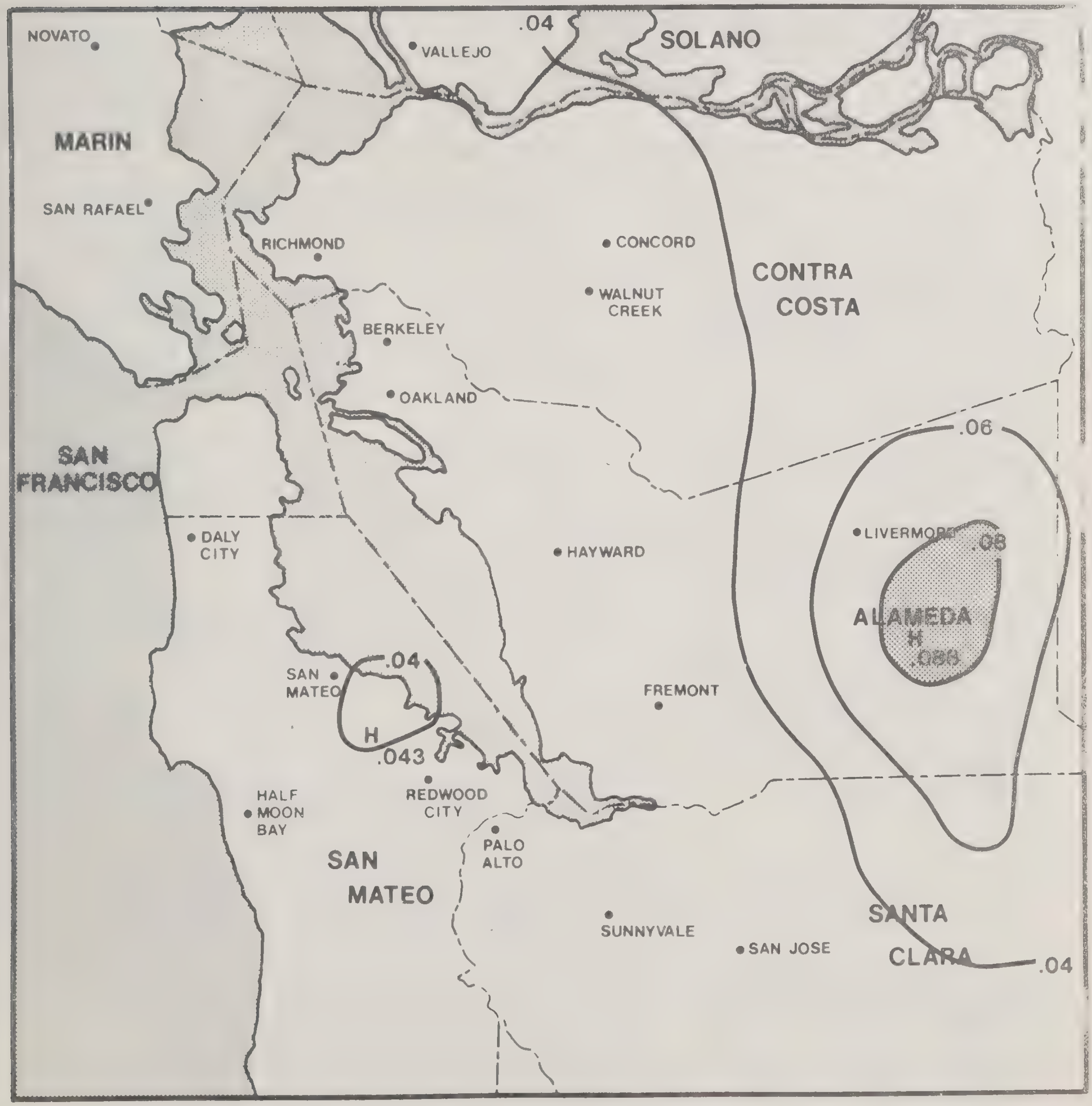
(Maximum Technological Controls Only)




Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 2000 baseline inventory

Figure 30. Example LIRAQ Results - 2000 Control Strategy Analysis

(Comprehensive Strategy without Additional NOx Controls)




Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 2000 baseline inventory

## Additional Controls on Existing Sources

Table 27 summarizes additional control measures that could be applied to provide the final increment of control necessary to achieve the standard. These measures have not been analyzed to the same level of detail as the measures in a comprehensive strategy.

Table 27. Additional Control Measures for Existing Sources and Approximate Emission Reduction Potentials[a]

| | 1985 | | 2000 | |
|---|---|---|---|---|
| | T/D | (%) | T/D | (%) |
| Stationary Sources | | | | |
| • Lower Reid Vapor Pressure | 15-30 | 2-4 | 20-35 | 2-3 |
| • Ban Small Gasoline Engines (e.g., Lawnmowers) | 10-15 | 1-2 | 20-30 | 2-3 |
| Mobile Sources | | | | |
| • Catalytic Converter Retrofit ('71-'74 LDV) | 6 | 0.6 | 0 | 0 |
| • Evaporative Retrofit (pre-1978) | 4 | 0.4 | 0 | 0 |
| Transportation Controls | | | | |
| • Increased Gas Tax<br>• Area License<br>• Smog Charges<br>• More Stringent Application of Previously-cited Transportation Controls | 3-5 | 0.3-0.6 | To be implemented with land use management measures | |
| Other | | | | |
| • Gasoline Rationing | Variable impact depending on stringency of application and user groups affected. (A 100% rationing program could yield an additional 170 ton/day emission reduction by the year 2000.) Obviously, a very direct and potentially effective means of reducing hydrocarbon emissions. | | | |
| • Prohibiting Certain Organic Solvent Use | Variable impact depending on stringency of application. (A 100% prohibition could yield an additional 160 ton per day emission reduction by the year 2000.) This measure assumes going considerably beyond the use of water-based and high solids content solvents and ACT on organic solvent evaporation. | | | |

[a]Assumes prior implementation of a comprehensive strategy.

The lowered Reid Vapor Pressure of gasoline would produce the undesirable side effect of making vehicle engines difficult to operate in cold weather. If only small changes in vapor pressure are required, engine start-up and warm-up problems are minimal but the corresponding effectiveness of this measure is also minimal. This program has been studied in the past on a number of occasions. A current study being conducted by the American Petroleum Institute has concluded this proposal has very limited potential as an air pollution control measure. The technical feasibility of this measure is questionable. Therefore, it does not appear to be an attractive option for the plan.

A ban on the use and/or sale of gasoline engines would include lawnmowers, chain saws, small gasoline powered pumps and generators, etc. In some cases alternatives can be found such as electric lawn mowers; however, these alternatives have other undesirable characteristics in terms on inconvenience (small gasoline engines are ideal for use in situations where electrical power is not conveniently available). Enforcement of this measure could be difficult. This measure has many very obvious administrative and implementation obstacles associated with it. It is not considered to be an attractive option for the plan.

The catalyst and evaporative retrofit measures for light duty vehicles are marginally effective by 1985 and decrease in effectiveness as the retrofitted vehicles age and are eventually junked. Previous retrofit programs attempted by the California Air Resources Board have been unpopular, since there are no direct benefits to the vehicle owner. These programs have a very short term benefit and require rapid adoption and implementation to achieve their greatest potential. Given the many technical problems associated with retrofit programs in the past, these control measures are not considered to be attractive option for the plan.

The transportation controls listed can yield emission reductions shown if stringently applied. For example, a 300% increase in the cost of gasoline via a gasoline tax would yield an approximate 1 to 2 tons/day hydrocarbon emission reduction in 1985. A close assessment of any particular proposals is recommended prior to inclusion in the plan.

The measures listed as "other" can yield a range of emission reductions depending on how stringently they are applied. A 100% gasoline rationing program would yield an additional emission reduction of about 170 tons/day by the year 2000, assuming prior implementation of the Comprehensive Strategy. A 100% prohibition on organic solvent use in the region could yield an additional emission reduction of about 160 tons/day beyond the Comprehensive Strategy. The effectiveness of intermediate levels of stringency are difficult to estimate, but are expected to be somewhat less than proportional. The impacts of these measures are also variable depending on the stringency of their application. Again, because of the very obvious problems associated with implementing these measures, they do not appear to be attractive options for the plan.

Management of the Growth of New Sources

An alternative to additional control over existing sources is to manage the growth of new sources of emissions. New Source Review (NSR) was

excluded from the air quality evaluation of the comprehensive strategy for a number of reasons:

- NSR is of variable effectiveness, depending on how stringent the adopted rule is (e.g., offset provisions).

- The specific form of NSR appropriate and acceptable to regional, State, and Federal regulatory agencies has been and continues to be debated.

- It is more appropriate to compare the effectiveness of NSR with respect to other control programs using a common baseline forecast. Such a forecast should not already include an NSR assumption.

In considering alternatives for attaining and maintaining the oxidant standard after all reasonably available controls have been implemented, NSR is of interest. Its effectiveness can range from zero to a maximum of approximately 100 tons/day or more reduced by the year 2000. The specific level of effectiveness achieved depends on the number and type of sources subject to review, and the specific review criteria used for determining compliance.

New Source Review can ensure sufficient hydrocarbon emission reduction to allow attainment of the oxidant standard and continued maintenance thereafter. In addition, NSR regulations are such that they can provide some degree of flexibility. Initially strict regulations can be changed and relaxed somewhat after it has been demonstrated that the air quality standards can be attained and maintained in spite of such relaxation.

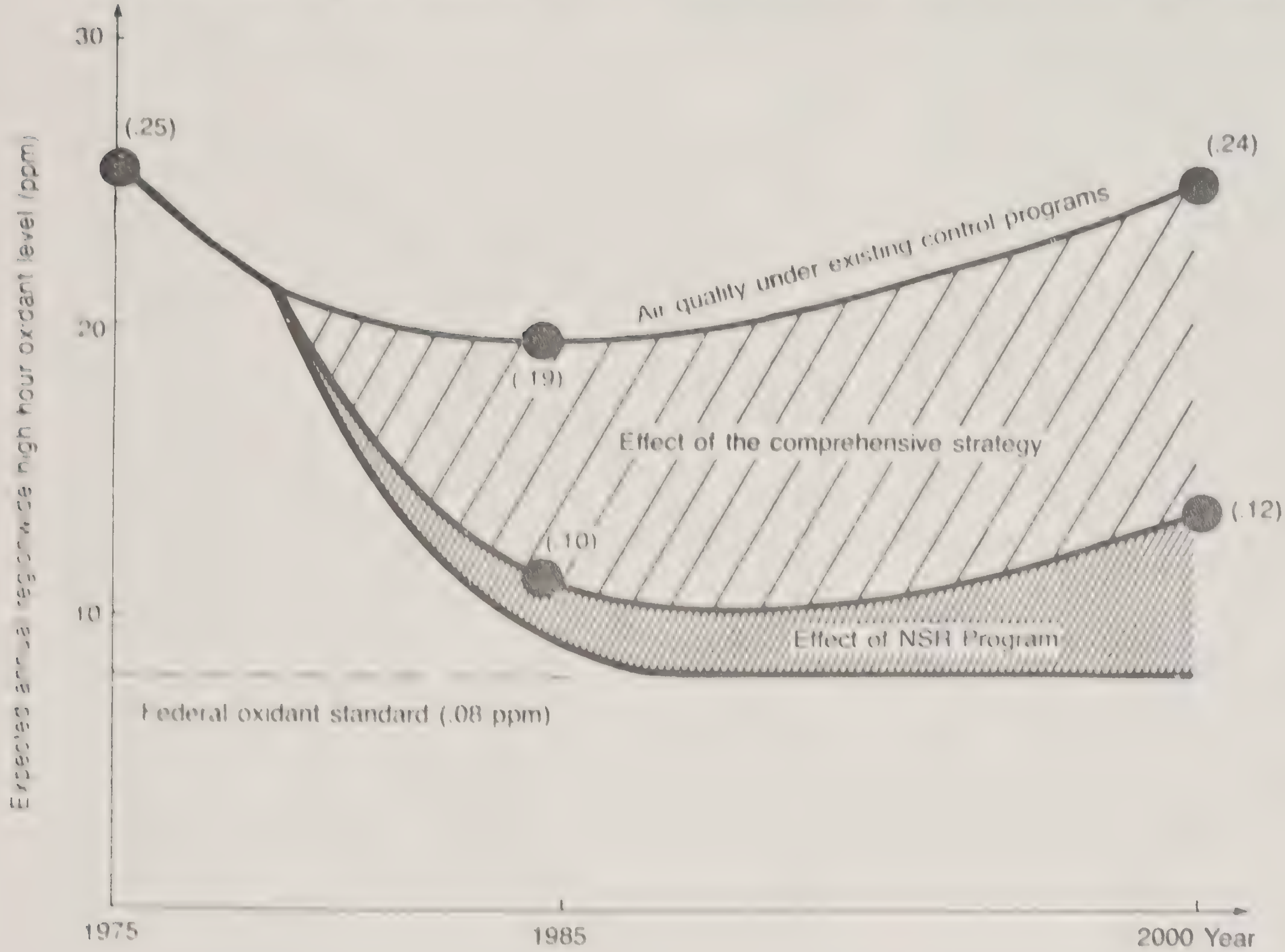
The potential role of NSR programs in relation to a comprehensive strategy and baseline air quality is illustrated in Figure 31. A comprehensive strategy is shown to provide the bulk of the air quality improvement between now and the year 2000, while the role of the NSR program could be to provide the incremental emission reduction (or prevention) necessary to attain and maintain the Federal oxidant standard. As a comprehensive strategy is made more stringent, restrictions on new source development can be made less stringent, and vice versa.

## NEW SOURCE REVIEW AND INDUSTRIAL GROWTH

Section 172 (b) of the Clean Air Act Amendments of 1977 provides that the plan required in the 1977 amendments for non-attainment areas (such as the Bay Area) must "expressly identify and quantify the emissions, if any,.... allowed to result from the construction and operation of major new or modified stationary sources..." In attempting to meet this requirement, an analysis was conducted of what emissions would occur with no growth. In projecting no growth in the region from 1975 to 1985, the following definition of no growth was assumed: 1975 population, employment, industrial activity, land use and transportation patterns with 1985 stationary and mobile source technological controls. Stated differently, the technological improvements projected for stationary and mobile sources in 1985 were assumed to be in place in 1975. For example, the 1975 travel patterns were combined with 1985 motor vehicle emission factors, an inspection and maintenance program was assumed to be

Figure- 31

**Relative roles of new source review and the comprehensive strategy in achieving and maintaining the Federal oxidant standard in the San Francisco Bay Region.**



in place, and the assumption was made that 1975 existing industries had implemented available control technologies (i.e., gasoline station vapor recovery, organic solvent regulations, floating roof tanks with secondary seals). This analysis projected hydrocarbon emissions in 1985 to be approximately 420 tons/day. Thus emission increases from all sources beyond the no growth scenario needed to be limited to less than 30 tons/day. The baseline projections indicated this level of increase would come from increased transportation activity (assuming no transportation control programs). Thus, all stationary source emissions needed to be held relatively constant. The key phrase in the 1977 Amendments is what growth "if any" will be permitted. According to the best information currently available, major new industrial growth can be permitted in the region under the NSR program only by using emission offsets on a case-by-case basis.

# Section-I

# PLAN RECOMMENDATIONS FOR PHOTOCHEMICAL OXIDANT

The air quality maintenance plan contains a broad range of control programs for photochemical oxidants. It includes more controls on stationary sources of air pollutants and on motor vehicles. It also includes proposals for changes in the region's transportation systems.

The recommended application of improved technological controls to stationary sources and motor vehicles would produce the most substantial improvements in air quality. The transportation measures would act to reduce automobile traffic, a major source of air pollutant emissions. The stationary and mobile source controls, together with transportation measures and new source review programs, would ensure eventual attainment and long-term maintenance of the Federal oxidant standard.

In addition to other requirements, an acceptable air quality plan must demonstrate numerically that the oxidant standard would be achieved and maintained. The Environmental Management Task Force directed the staff to prepare such a plan, and to present options to measures in that plan. Approximately 100 measures were analyzed for their effectiveness in reducing emissions. The recommended plan is described in this section. Options for measures in the plan are described in Section E. As described in Chapter I, changes in the draft plan issued in December 1977 were made as a result of the public review and approval process. Certain measures presented in the draft were deleted from the plan adopted by the General Assembly of the Association of Bay Area Governments. These changes were made for a variety of reasons. Some measures were dropped because they were not considered effective or easily implemented. Other measures were deleted from the initial plan for additional study. The General Assembly specifically reserved for itself a right to make changes in all parts of the Environmental Management Plan during the continuing planning process, including the air quality plan. That process is in keeping with the policies and actions adopted in the air quality portion of the EMP.

The plan is diverse and flexible. The diversity is an advantage because it reduces the reliance on a single type of control. The plan is flexible because the new source review program can be applied with varying degrees of stringency as appropriate to meet the standard, Flexibility is desirable to accommodate uncertainty. In Section D, uncertainties relating to forecasting and the analytical tools used for the preparation

of the air quality plan are discussed. There are also uncertainties in estimating the effectiveness and costs of control programs that have not yet been implemented, and for which only limited information and experience are available.

The transportation actions would be implemented by local agencies and would demonstrate good faith efforts to meet and attain the oxidant standard as expeditiously as practicable. It is clear that the partnership of Federal-State-regional-local efforts called for by this plan to improve air quality would demonstrate reasonable progress toward attainment and could qualify the region for a five-year extension in meeting the Federal standard.

## RECOMMENDATIONS

The plan recommendations are summarized in Table 28. For each action listed in the first column, subsequent columns of the table indicate the agencies responsible for implementing the action, the implementation schedule, costs, sources of financing, direct benefits in terms of emission reductions, and other environmental, institutional/financial, economic, and social impacts of the action.

Figure 32 highlights in graphic form the schedule for implementation of each of the plan recommendations. Most of the recommendations could be adopted by appropriate agencies within two years of plan approval. However, full implementation would realistically require several years beyond the adoption phase, particularly for the most significant programs such as the use of available control technology (ACT). It is therefore unlikely that the oxidant standard can be met in the Bay Area by 1982. The ultimate 1987 target year for attainment set by the 1977 Clean Air Act Amendments can be met through implementation of this plan.

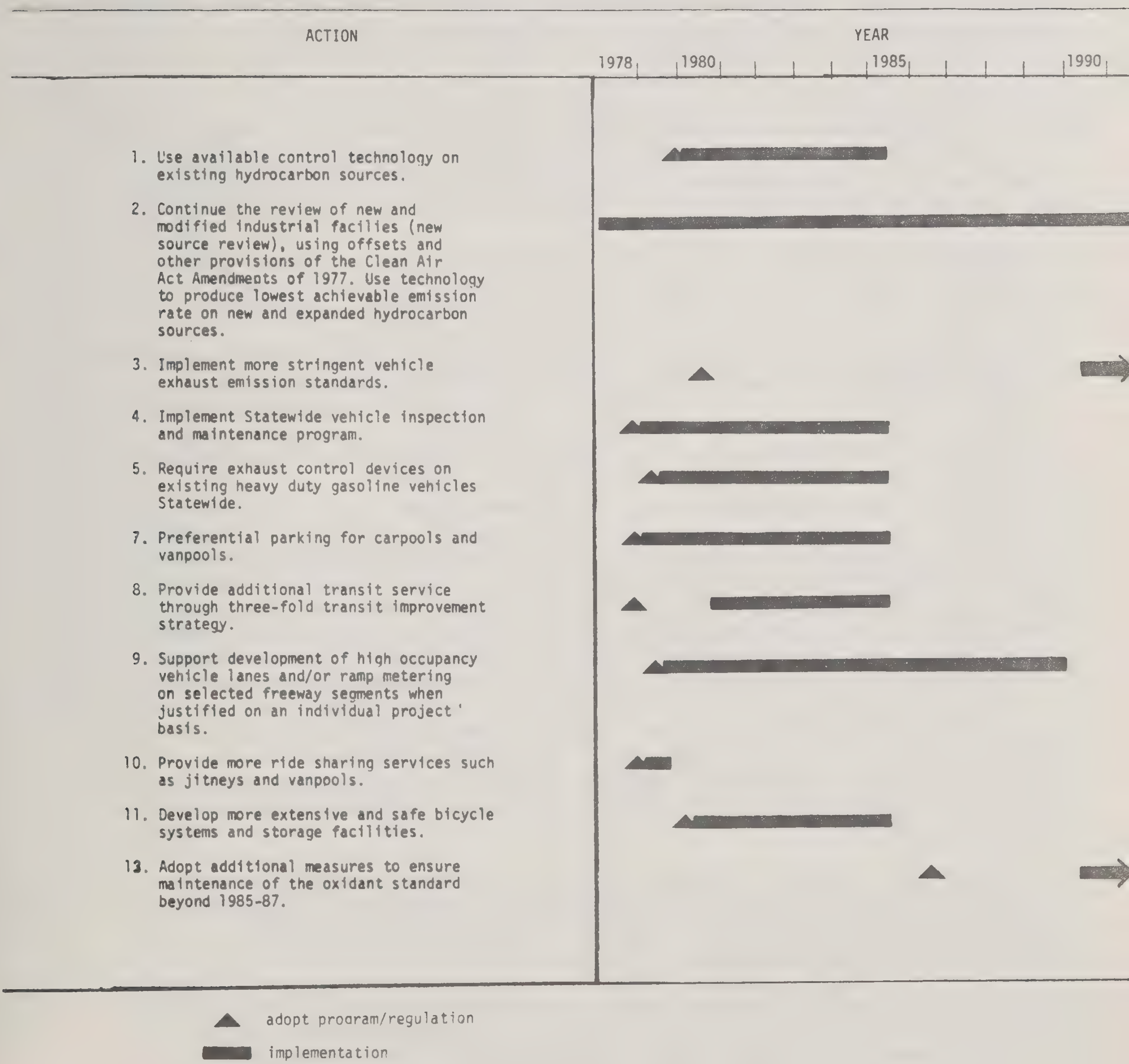
The following narrative provides background information for the recommended actions.

### I. General Policy: Reduce Hydrocarbon Emissions from Stationary Sources

The actions necessary to implement this policy must focus on both existing and future sources of hydrocarbon emissions in the Bay Area. Heavy reliance is placed on requiring the use of advanced emission control technology for existing sources. New sources of emissions will face stringent review requirements before being allowed to locate in the region.

It is intended that the air quality plan adopted for the Bay Area facilitate a reasonable level of industrial and commercial growth while achieving reasonable further progress toward attainment of ambient air quality standards. The air quality plan provides that this be accomplished through continued review of new and modified industrial and commercial facilities (new source review) using offset and/or other provisions of the Clean Air Act Amendments of 1977 to allow for a reasonable level of growth. Currently the only means of allowing major industrial growth is the case-by-case offset provision of new source review regulations. However, it is too soon to determine whether this provision will in fact allow a reasonable level of industrial growth. Therefore, in the continuing planning process (described in Section X).

FIGURE 32. SCHEDULE FOR IMPLEMENTATION OF THE PLAN RECOMMENDATIONS FOR PHOTOCHEMICAL OXIDANT



as emission reductions and economic impacts are monitored, alternative procedures for permitting industrial growth will be evaluated and considered for inclusion in updated versions of the air quality plan.

Action 1: Use available control technology on existing hydrocarbon sources, allowing a reasonable amortization schedule for air pollution control equipment. Available control technology means an emission limitation based on the maximum degree of reduction of hydrocarbons emitted from or which results from any emitting facility, which the permitting authority, on a case-by-case basis, taking into account energy, environmental and economic impacts and other costs, determines is achievable for such facility through application of available methods, systems and techniques. Technology for selected processes, which have been included in the projections of emission reductions, are as follows:

| Process | Technology |
|---|---|
| Organic storage | Secondary seals |
| Tar pots | Loading door assembly |
| Paint spray booth | Incinerator or low-no solvent coatings |
| Architectural coating | Low solvent coatings |
| Dry cleaning | Closed system with solvent recovery |
| Cable tar coating | Incineration |
| Gasoline bulk storage | Floating roof or fixed roof & vapor recovery |
| Auto service station storage tanks | Balanced system |
| Auto fill operations | Balance system |

The legislation establishing the BAAPCD did not permit the BAAPCD to specify control equipment to be used in meeting control regulations and emission limitations. Therefore, until recently, all BAAPCD regulations were performance regulations. The regulation specified limits on the amount, concentration, or visible appearance of the emission; the means of complying with the regulation was the prerogative of the operator of the source.

More recently, State laws have been altered to remove the prohibition against specification of equipment thus allowing the BAAPCD to require the use of the most effective technology actually available and proven in use, not necessarily in the Bay Area. It does not include unproven theoretical devices.

An ACT rule would require that existing operations use specified air pollution control techniques, such techniques being specified by the BAAPCD. The rule could be adopted by the end of 1979, but five years should be allowed for full implementation.

Action 2: Continue the review of new and modified industrial facilities (new source review), using offsets and/or other provisions of the Clean Air Act Amendments of 1977 to allow for a reasonable level of growth consistent with the requirements of the act. Use technology to produce the lowest achievable emission rate (LAER), as defined by the Clean Air Act Amendments of 1977, on new and expanded hydrocarbon sources.

Since July of 1972 the BAAPCD has had in effect a permit rule (Division 13, Regulation 2) specifying the authority to deny a permit to construct (Section 1309) or to operate (Section 1310) if the new source will "interfere with the attainment or maintenance of any air quality standard adopted by the California Air Resources Board or the Environmental Protection Agency...."

Section 1311.2 of that same regulation specifies that a permit will not be denied if the emissions of each contaminant from a facility are significantly less than from the original facility. Thus a degree of offset is acknowledged, i.e., if emissions from existing operations are reduced by more than the emissions from a new operation, the new operation will be allowed. It is important to understand that Section 1311.2 is interpreted to mean that the reduction of existing emissions must be accomplished from facilities operated by the same owner, i.e.,the owner of the proposed facility, and at the same location. Additionally, Section 1311.2 requires offset to be for the same pollutant type, e.g., $SO_2$ for $SO_2$, not carbon monoxide for hydrocarbons.

This action would retain the present BAAPCD permit rule with or without expansion of or modifications to the offset provisions. Depending on the success of all other air pollution controls recommended in this plan, the New Source Review rule would require:

- The prohibition of some new industries with significant emissions (for example, an industry that cannot meet the New Source Review criteria or could not obtain the designated emission offset).

- Increased cleanup from existing sources through offsets/negotiation, or in some cases prohibition of modifications proposed by existing sources

II. General Policy: Reduce Hydrocarbon Emissions from Motor Vehicles

The actions necessary to implement this policy change with time. Initially, effort would be focused on implementing exhaust controls on gasoline powered trucks and a program of mandatory vehicle inspection and maintenance for both autos and trucks. These programs will act to minimize emissions from existing vehicles. On a longer term basis, more stringent vehicle emission standards are recommended as new engine technologies become available for mass production. The mandatory inspection and maintenance program would still be necessary on a long term basis to ensure that the newer, cleaner vehicles being produced continue to perform at their design levels after they have been operated for some time.

Action 3: Implement more stringent vehicle (light duty and heavy duty) exhaust emission controls--approximately 50% reduction below 1977 prescribed levels.

Currently promulgated emissions standards for motor vehicles will achieve substantial emissions reductions from light and heavy duty vehicles in the period 1980-1985. These reductions, however, will eventually be offset by growth in vehicle population and vehicle miles traveled that is anticipated between 1985 and 2000. For example, in 1985, baseline motor vehicle hydrocarbon emissions are projected to be 213 tons per day. In 2000, the emissions increased to 267 tons per day.

The recommendation requires that the exhaust emission characteristics of vehicles manufactured after 1990 be reduced by:

- 50% from the ultimate levels promulgated under the 1970 Clean Air Act Amendments for light duty vehicles. The requirements (i.e. grams per mile standards) in the 1977 Amendments are approximately the same as the 1970 Clean Air Act.

- 50% from the ultimate 1983 Air Resources Board standards for medium and heavy duty vehicles.

The resultant emission standards would be:

| | grams/mile HC | CO | $NO_x$ |
|---|---|---|---|
| light duty | .20 | 1.70 | .40 |
| medium duty | .25 | 4.50 | .15 |
| heavy duty* | .25 | 12.50 | 4.5 |

Action 4: Implement Statewide inspection/maintenance program for light and heavy duty vehicles.

While automobile emissions can be controlled by a variety of basic engine modifications and exhaust treatment devices, the state of tune of the vehicle also affects emissions significantly, regardless of what emission standards the vehicle was originally designed to meet. For example, misfiring spark plugs can increase unburned hydrocarbon emissions tenfold. An incorrectly adjusted idle air/fuel ratio can double carbon monoxide emissions. Defective emission control components can cause the emissions of late model cars to equal those of uncontrolled vehicles. A program for identification and repair of vehicles with excessive emissions caused by maladjusted or defective components has the potential to significantly reduce automotive emissions.

The recommendation requires inspection of all light duty automobiles starting in 1982 and the inspection of medium duty vehicles beginning in 1985. The inspections (which would take about five minutes) consists of: visual safety inspections, visual inspection of the emission control systems and exhaust smoke; automatic computer analysis of carbon monoxide and hydrocarbon exhaust gas emissions (could also include oxides of nitrogen, if loaded tests were performed), and an automatic printout of the inspection report comparing the emissions measured to acceptable limits for that particular model. If the vehicle fails the inspection it is required to be repaired by a certified mechanic and then be reinspected. If the vehicle cannot be repaired in order to meet the standard of performance for under a pre-established amount (e.g. $75) then the vehicle owner may be given a waiver for that year. This would not relieve the vehicle owner from future year inspections.

Action 5: Require exhaust control devices on existing heavy duty gasoline vehicles Statewide.

The regulation of emission levels from heavy duty vehicles (over 6,000 pounds gross vehicle weight) has lagged behind efforts to control light duty vehicle emissions. The slower turnover rate for heavy duty vehicles means they remain in use for a longer time than light duty vehicles. Thus, even with emissions standards for heavy duty vehicles, some control program is needed to minimize emissions from in-use vehicles before they are replaced by newer and cleaner vehicles.

*grams brake horse power

The recommendation requires that all heavy duty gasoline (HDG) vehicles manufactured in 1971-1982 be retrofitted with a catalytic converter by 1985. Diesel vehicles are exempted because they emit relatively small amounts of hydrocarbons and because it is impractical to install a converter. Pre-1971 models are exempt because they require leaded gasoline (leaded gasoline contaminates the catalyst). Post-1982 vehicles are assumed to be equipped with catalysts in order to meet the 1982 emissions standards already adopted by the California Air Resources Board.

Action 6: Permit no further delays in implementing strict emission requirements on automobiles, provided, however, that if such delays are granted by either the California Air Resources Board or Congress, this region should be provided with extensions beyond the deadlines required by the Clean Air Act Amendments of 1977.

Since automobiles and other vehicles are a major contributor to hydrocarbon emissions, any delays granted in the implementation of emission standards will hamper the region's ability to attain and maintain the oxidant standard. If such delays are granted, it will be necessary to revise the deadlines of the Clean Air Act.

## III. General Policy: Reduce Motor Vehicle Emissions Through Transportation Actions to Reduce Vehicle Use

The objectives of the transportation actions recommended are to encourage use of public transit and other high occupancy vehicle travel modes. At its March 22, 1978 meeting the Metropolitan Transportation Commission adopted guidelines with respect to the provisions of the air quality plan. The MTC statement is as follows:

"Guidelines

The Commission endorsed the following guidelines which are supported by existing Regional Transportation Plan (RTP) policies:

1. MTC will use its funding and project approval power to support compliance with the final land use plan as adopted by ABAG and included in the AQMP. (Note: No land use plan is included in the AQMP.)

2. MTC will continue to make air quality a major consideration in project funding decisions.

3. Because the impact of specific pricing control measures appears quite small, MTC will consider such control measures only under certain conditions:

    a. When problems of social and economic inequities in the transportation system are minimized and adequate transportation alternatives exist.

    b. When such pricing measures are necessary to insure that the entire transportation plan is feasible.

    c. When such a measure is evaluated in detail and subjected to full scale public hearings.

4. MTC policy supports measures which improve or enhance alternatives to the automobile without penalizing those dependent on the auto. These alternatives include transit, carpooling and bicycle systems.

5. Existing MTC policy supports the concept of high occupancy vehicle lanes when they are found to be advisable on a project and location specific basis.

6. MTC, in applying these guidelines and in developing additional transportation measures to improve air quality, will undertake adequate analysis and provide for public review to assure that any proposal will achieve air quality objectives while remaining consistent with other RTP objectives.

7. MTC recommends a strategy of high density residential or commercial zoning around all BART stations and around all major fixed point transportation centers, where it would improve use of public transit without causing other major environmental problems. This proposal would support better utilization of the regional transportation systems. (Note: The Executive Board considered this suggestion, and decided not to include it in the AQMP recommended to the General Assembly.)"

Action 7: Preferential parking for carpools and vanpools.

Preferential parking would be provided to carpoolers by giving them (1) reduced parking charges in areas with paid parking, such as central business districts, or (b) a time savings in areas of free parking, such as large suburban employers.

Carpooling can be one of the more effective ways of improving the efficiency of the transportation systems, both from an air quality and operations viewpoint. However, people are frequently reluctant to carpool because of the time lost in picking up members.

The carpool parking incentives are modeled after a program that Caltrans is currently testing. State lots are leased to operators at a reduced rate on condition that (1) they only allow carpools to park, and (2) charge no more than $10/month. Carpools sign up for a space and there is currently a waiting list.

The time incentive would work by having large employers set aside close-in parking for carpools. This would compensate for the time lost in the pick-up phases.

Action 8: Pursue a three-fold transit improvement strategy. (1) MTC, in cooperation with transit operators, will adopt service improvement objectives which can be financed by the existing commitment of resources to transit. Improved capacity, service, and ridership are contemplated. A measure of the improvement expected should be agreed to and committed to in the context of the RTP by October 1, 1978. (2) MTC will continue its efforts to identify the need for additional services (as it has, for example, in the elderly and handicapped program and more recently in the Minority Transportation Needs Assessment Project (MTNAP) and to pursue providing

additional services as they are justified. A measure of the improvement expected will continue to be developed as these special needs are examined and as the demand for transit services expands generally. (3) During the commute hours all major transit systems in the Bay Area are at capacity. Any substantial increase in ridership will be dependent upon increased Federal or State financial assistance. The amount of ridership increase is directly affected by the amount of increased State and Federal funding. Provision of additional transit capacity represents a positive transportation strategy. Thus the State and Federal governments are encouraged to provide necessary funding support for transit improvements to offset any air-quality deficiencies caused by deleting less desirable transportation control measures. Without this financial support, transit capacity cannot be significantly expanded.

The additional service would help make transit more competitive with respect to the auto by providing more coverage or better frequency. Existing funding services could not support this new burden. Additional revenues from Federal and State governments would be required.

The expansion program would be phased over 5 years, and would begin in 1980.

Action 9: Support development of high occupancy vehicle lanes and/or ramp metering on selected freeway segments when justified on an individual project basis.

Some form of preferential treatment (special lanes on the freeways and/or ramp metering with special lanes on ramps) could be given to buses and carpools on the following freeway segments; for example:

- Route 580 from Route 24 to the Bay Bridge
- Route 80 from San Pablo Dam Road to the Bay Bridge
- Route 101 from the San Francisco Airport to the Route 280 Diamond Lane

Since these would require detailed planning, funding approval and construction, they would not be operational until 1985.

This measure is another incentive to induce commuters to take transit or to form carpools by saving them time. These particular example segments of freeway are frequently congested during peak hours and preferential treatment could result in significant time savings.

Action 10: Provide more ride sharing services such as jitneys and vanpools. Objectives need to be developed and monitored to gauge the desirable rate of expansion.

Currently, a carpool matching program, RIDES, is being administered by Caltrans. It is aimed at major employment centers, with participants solicited primarily by general advertising campaigns. This has been a successful program to date, but the AQMP proposal would intensify the effort. Increased employer participation would be sought for direct employee contact or adjustment to flexible working hours. Also, secondary employment centers could be served by tailoring campaigns to specific areas.

With respect to vanpools, the Golden Gate District is starting a demonstration program to initiate vanpools from Marin County. A program such as this could be expanded to the regional level. One proposal is for the non-stock, non-profit corporation to provide standardized minimum risk leases of vans to employers and employee groups meeting the criteria for such a program. Lease terms and specifications could be prearranged through a competitive bidding procedure.

Action 11: Develop more extensive and safe bicycle systems and storage facilities. Objectives need to be developed and monitored to gauge the desirable rate of expansion.

The system would be directed toward major employment centers, commercial centers, and transit terminals throughout the region. The paths would be painted on existing streets with approximately one-half mile intervals between parallel paths. Storage would comprise lockers, racks, and whatever special storage areas may be provided by the private sector. Initial planning for the measure would commence in 1978. The physical construction of the system would begin in 1980 and continue through 1985.

This measure has the potential to improve regionwide air quality by diverting both work and non-work trips of less than 2.5 miles to bicycles. Sunny and warm days, when the photochemical problem is most serious, are also the most conducive to bicycle riding. Emissions from cold starts and hot soaks will produce the majority of mobile emissions by 1985. Thus, even though bikes would not reduce vehicle miles traveled significantly, they will have a significant impact on emissions by reducing the number of trips.

Action 12: MTC is requested to consider the following action: "Complete construction of certain portions of State freeway systems in which there are now pollution-causing gaps."

If agreed to by MTC, a determination of where such pollution-causing gaps occur would be necessary. Any consideration of construction to eliminate them would be analyzed and assessed as a part of the Regional Transportation Plan. Actual construction would not proceed prior to project level planning/design actions taken by Caltrans.

IV. General Policy: Ensure maintenance of the oxidant standard beyond 1985-87.

Action 13: Adopt between 1985 and 1987, and implement in 1990 or thereafter, one or more of the following measures to ensure maintenance of the oxidant standard through the year 2000, subject to further evaluation of the measures during the continuing planning process:

1. Reduce hydrocarbon emissions from small gasoline engines.
2. Reduce hydrocarbon emissions from off-highway mobile sources
3. Implement more stringent vehicle exhaust emission controls--approximately 60-80% reduction below 1977 prescribed levels.
4. Provide additional transit

These actions are to maintain the oxidant standard beyond 1985-87. The Clean Air Act requires the AQMP to demonstrate the ability to meet established Federal air quality standards (in this case the Federal photochemical oxidant

standard) and to maintain the standard following attainment. Because they are needed for long-term maintenance, responsible agency(s) action to adopt and implement these additional measures will not be necessary prior to 1985. The maintenance measures are identified for further analysis during the continuing planning process, with one or more of the measures to be adopted as necessary to ensure maintenance of the current Federal oxidant standard after 1985-87. Part of the analysis will include detailed assessment of the impacts of the substitute maintenance measures.

Measures 3 and 4 are self-explanatory. Measure 1 involves controls for small gasoline engines. Two major categories of engine equipment are involved. The lawnmower (lawn and garden equipment) category consists of push-type mowers, riding mowers, garden tractors, rototillers, golf carts, and miscellaneous lawn and garden implements. The miscellaneous utility engines category consists of small internal combustion engines in equipment such as chainsaws, generators, pumps, compressors (used in painting, sandblasting, surface coating). Engines are either 2-stroke or 4-stroke, with the former being significantly dirtier. Emissions from 2-stroke engines may be up to seven times the emissions from a 4-stroke engine.

Measure 2 involves two major mobile source categories. The farm equipment category includes many types of farm equipment powered by internal combustion engines, but predominant is the farm tractor. The construction equipment category includes vehicles and other equipment used in construction and earth moving, mining and quarrying, and lumber industries and other miscellaneous equipment. Predominant units are tractors (wheeled and track laying); other types are scrapers, graders, loaders, motor generators and compressors. Power is of two types (gasoline and diesel) with the latter being more of an issue for $NO_x$, particulates and oxides of sulfur.

The four maintenance measures are estimated to reduce hydrocarbon emissions by 24 tons/day by the year 2000. This reduction is the current estimated tonnage reduction necessary to show long-term maintenance of the Federal photochemical oxidant standard.

## A Final Note on Uncertainty and Its Relationship to the Continuing Planning Process

As has been pointed out elsewhere in this chapter, there are uncertainties about the effectiveness of the controls included in the plan adopted by the General Assembly. A case in point is the role of New Source Review (NSR) in the Bay Area plan for managing the growth of new or modified industrial sources of pollution. Assuming provisions for case-by-case offset, such a program in theory allows for growth while net emission reductions are achieved. Nobody can "document or define" with any certainty what potential reductions are available from NSR or how such reductions will be achieved. There are a number of reasons why accurate estimates of the impact of NSR on emissions reduction are unavailable (if not impossible):

1) The national (and California) experience with such concepts as external trade-off and offsets are very limited and far too sketchy to attempt any regional extrapolations.

2) The industrial siting process is not well understood, especially from the perspective of how regulatory requirements impact it.

3) Both BAAQMD and the ARB are proposing alternatives to the current NSR rule.

4) The definitions of RACT and BACT vis a vis specific control technologies, and the relationship of RACT to BACT constantly changes over time; depending on how stringent these definitions are over time will directly impact the potential effectiveness of NSR.

5) The potential effectiveness of NSR is directly impacted by the time schedule for implementation of reasonably available control measures (RACM) required by the 1977 Clean Air Act; this relationship between NSR effectiveness and the RACM effectiveness differs from region to region depending on how the two programs are separately administered.

Because of the uncertainties in the forecasts, during the continuing planning process emission reduction estimates will be closely monitored.

For example, calendar year 1978 was the first complete year of the current Bay Area New Source Review Rule. The Bay Area Air Quality Management District has reviewed the permit record for that period with the following observations:

- The net reduction in volatile organic compound (i.e., hydrocarbon) emissions in the Bay Area from the amount which would otherwise be expected due to normal growth was 7 tons per day;

- Of that 7 tons per day reduction, 4 tons per day were due to denials of permits which would otherwise have been approved if no New Source Review Rule were in effect;

- The remaining 3 tons per day reduction is due to "on-site banking," where, for example, existing sources have reduced emissions in advance of making planned modifications. (These emissions may be reclaimed within a five year period.)

- There were no off-site trade-offs applied for in 1978, and it is expected that the greatest potential for achieving emission reductions through New Source Review is through this mechanism.

The effectiveness of the other programs recommended will also be closely monitored during the continuing air quality planning process. Appropriate adjustments will be made as additional information is gathered and the uncertainties are reduced. But to repeat a point made earlier in this chapter, the forecasts on which this plan is based are as objective, rigorous and accurate as possible at this time.

Table 28

# PHOTOCHEMICAL OXIDANT

**recommendations**

| RECOMMENDATIONS | DIRECT BENEFITS (Hydrocarbon emission reductions, tons/day) 1985 2000 | RESPONSIBLE AGENCY (or agencies) | SCHEDULE FOR ACTION A - Adoption I - Fully Implemented | TOTAL COST/YEAR OF RECOMMENDED ACTION | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|

# I. Stationary source controls

GENERAL POLICY: REDUCE HYDROCARBON EMISSIONS FROM STATIONARY SOURCES

| | | | | | | |
|---|---|---|---|---|---|---|
| **Action 1**<br>Use available control technology on existing hydrocarbon sources, allowing a reasonable amortization schedule for air pollution control equipment. Available control technology means an emission limitation based on the maximum degree of reduction of hydrocarbons emitted from or which results from any emitting facility, which the permitting authority, on a case-by-case basis, taking into account energy, environmental and economic impacts and other costs, determines is achievable for such facility through application of available methods, systems and techniques. Technology for selected processes, which have been included in the projections of emission reductions, are as follows: | 225 337 | Bay Area Air Pollution Control District (BAAPCD) | A - 1980<br>I - 1985 | \$529,000[a]<br>*\$18,000,000[b]<br><br>*Costs are considered underestimates due to choice of discount rate. | Administrative/Regulatory<br>- Ad valorum tax revenues<br>- ARB subvention Funds<br>- Federal Clean Air Act funds<br><br>Operating/Maintenance<br>- Private<br><br>Capital<br>- Private<br>- California Pollution Control Financing Authority<br>- Federal Small Business Administration Loan Programs | BAAPCD Enabling Legislation |

| PROCESS | TECHNOLOGY |
|---|---|
| Organic storage | Secondary seals |
| Tar pots | Loading door assembly |
| Paint spray booth | Incinerator or low/no solvent coatings |
| Architectural coating | Low solvent coatings |
| Dry cleaning | Closed system with solvent recovery |
| Cable tar coating | Incineration |
| Gasoline bulk storage | Floating roof or fixed roof & vapor recovery |
| Auto service station storage tanks | Balanced system |
| Auto fill operations | Balance system |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Action 2**<br>Continue the review of new and modified industrial facilities (new source review), using offsets and/or other provisions of the Clean Air Act Amendments of 1977 to allow for a reasonable level of growth consistent with the requirements of the act. Use technology to produce the lowest achievable emission rate (LAER), as defined by the Clean Air Act Amendments of 1977, on new and expanded hydrocarbon sources. | Combination of ACT in Action 1 and LAER are estimated to reduce hydrocarbon emissions by 225 tons/day in 1985 and 337 tons/day in 2000. From NSR and offsets, 64 tons/day are targeted for 1985. Additional emission reductions required to maintain standards will depend on regional growth rates and success of other control programs. It is highly unlikely that more than 150 tons/day can be reduced by 2000. | BAAPCD | Currently being implemented | Increased cost to industry for emission offset purchases. | | BAAPCD enabling legislation |

[a] Public agency

[b] Private

## ENVIRONMENTAL IMPACTS

Air Quality

- See "Direct Benefits" column.

Water Quality

- No impacts.

Physical Resources

- Between 18,000 and 25,000 gallons per day of organic solvents could be conserved from proposed organic solvent controls.
- Available control technology would consume construction materials, water, disposal facilities, etc. However, it does comprise many things and has not been identified with regard to Bay Area industrial operations. Consequently, more detailed assessments will require further definition of ACT.

Energy Resources

- Use of available control technology for hydrocarbon emissions (including the use of high solids/water base coatings and closed systems for organic liquid storage) should not result in a net energy penalty. Certain technologies such as industrial water based coatings and solvent incineration involve energy penalties, while other technologies such as high solids coatings and improved vapor recovery systems produce energy savings.
- Current new source review activities could be perpetuating excessive energy use by old and inefficient plant operations that are presently unable or unwilling to meet stringent NSR requirements in order to modernize.

Amenities

- The principal impact of the stationary source actions would be their contribution toward the improvement of air quality in the Bay Area.

## INSTITUTIONAL/FINANCIAL IMPACTS

Institutional

- The governmental structure for implementing these control measures already exists in the Bay Area Air Pollution Control District which actively enforces air pollution control programs in the Bay Area. The measures being proposed for consideration here are simply more stringent extensions of measures already in force for control of industrial and stationary sources of air pollution.

Financial

Direct Public Costs of Implementation

- See public costs (a) in the column headed "Total Cost/Yr. of Recommended Action."

Fiscal Effects on Local Governments

- The BAAPCD operating funds are obtained from local property taxes and State and Federal grants. Exactly how the costs will be apportioned is presently unclear; however, no direct costs to local governments are expected

## ECONOMIC IMPACTS

Production of Goods and Services

- Increased technological dependence by the Bay Area industrial sector to improve regional air quality will require considerable capital investment. In some instances, these added restrictions and costs may adversely affect the competitive position of local industries inter-regionally where the cost of these investments may be passed on to the consumers.
- Measures pertaining to coatings will require that process changes occur in order to reduce levels of air pollution. Changed product composition resulting from different processes could result in reduced durability and therefore increased product liability potential for the coatings industry. Phased implementation of this program should help minimize these problems.
- Increased cost to industry for emission offset purchases
- Special consideration may be needed for food processing industry in meeting other public health standards.

Income and Investment

- See Private Costs (b) in the column headed "Total Cost/Yr of Recommended Action."

Consumer Expenditures

- While the direct costs of implementing these measures will initially fall upon industry, many, if not all of them will find their way to the consumer and local taxpayer. Since supporting this type of activity is not the type of expense to result in increased productivity or in direct economic return for most of them, it may be considered an inflationary cost. In addition, higher prices for Bay Area products reflecting this cost may become less attractive to non-Bay Area consumers who may look elsewhere for the same product. On the other hand, consumers and local taxpayers may view the costs of implementation as an investment having non-economic but equally valuable return. In either case, implementation of the proposed control measures is likely to result in an increased cost of consumer goods.

## SOCIAL IMPACTS

Housing Supply

- No impact.

Physical Mobility

- No impact.

Health and Safety

- Air quality standards for each of the pollutants are based upon scientifically derived air quality criteria. Air quality criteria are an expression of current information concerning the relationship between various concentrations of pollutants in the air and their adverse effects on man and his environment. The control measures being proposed are designed to meet the standards, i.e., to reduce the concentration of various pollutants in the air. Pollutant concentration reductions from the air will reduce potentially adverse effects from these substances, thereby favorably impacting public health.
- With regard to safety, the stationary source control program may eliminate many hazards associated with the use and storage of combustible solvents.

Sense of Community

- No impact.

Equity

- A major question of equity involves the competitive position of Bay Area industries that are placed under the restrictions and controls proposed by the stationary source measures. This question can be extended to employment opportunities for the local population. Some employment and business opportunities will be created in local industries producing air pollution control equipment. However, whether or not those opportunities will be available or sufficient to offset increased unemployment resulting from competitive disadvantage (see "Production of Goods and Services") is an issue requiring further exploration. The willingness of the U. S. Environmental Protection Agency and the California Air Resources Board to require similar measures outside of the Bay Area is of obvious concern to the region.

| RECOMMENDATIONS | DIRECT BENEFITS (Hydrocarbon emission reductions, tons/day) 1985 | 2000 | RESPONSIBLE AGENCY (or agencies) | SCHEDULE FOR ACTION A - Adoption I - Fully Implemented | TOTAL COST/YEAR OF RECOMMENDED ACTION | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|---|

## II. Mobile source controls

GENERAL POLICY: REDUCE HYDROCARBON EMISSIONS FROM MOTOR VEHICLES

| RECOMMENDATIONS | 1985 | 2000 | RESPONSIBLE AGENCY (or agencies) | SCHEDULE FOR ACTION | TOTAL COST/YEAR | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|---|
| **Action 3** Implement more stringent vehicle (light duty and heavy duty) exhaust emission controls--approx. 50% reduction below 1977 prescribed levels. | - | 62 | California Air Resources Board (CARB) | A - 1980<br>I - 1990 | \$3,000[a]<br>\$24,910,000[b] | - Private | Mulford-Carrell Air Resources Act |
| **Action 4** Implement Statewide inspection/maintenance program for light and heavy duty vehicles. | 23 | 58 | CARB and/or Bureau of Automotive Repair | A - 1978<br>I - 1985 | \$1,395,000[a]<br>\$16,892,000[b] | - I/M Program revenues<br>- State General Fund | New Legislation Required |
| **Action 5** Require exhaust control devices on existing heavy duty gasoline vehicles Statewide. | 25 | - | CARB | A - 1979<br>I - 1985 | \$8,000[a]<br>\$1,534,000[b] | - Private | New Legislation Required |
| **Action 6** Permit no further delays in implementing strict emission requirements on automobiles, provided, however, that if such delays are granted by either the California Air Resources Board or Congress, this region should be provided with extensions beyond the deadlines required by the Clean Air Act Amendments of 1977. | | | | | | | |

[a] Public agency

[b] Private

## ENVIRONMENTAL IMPACTS

Air Quality

- o See "Direct Benefits" column.

Water Quality

- o No impact.

Physical Resources

- o No significant impact on physical resources is expected from more stringent exhaust emission controls where such can be achieved by further technological improvement of conventional vehicle engines. However, if new engine designs requiring alternative fuel sources are pursued to achieve this measure, then new materials may be required to manufacture these engines. (For example, electrically-powered vehicles may require special material to construct batteries capable of providing satisfactory power performance.) Of greater significance is the possibility that new engine technologies will utilize less specialized fuels, thereby reducing dependence on gasoline or petroleum per se.

Energy Resources

- o Mobile source emissions controls will produce significant energy savings through improved maintenance of engines and emission control systems, as well as through the eventual development of new engine technologies. The inspection and maintenance program and the retrofit program for heavy duty gasoline trucks could save approximately 10,000,000 gallons of gasoline per year, or about 240,000 barrels of oil per year. New engine technologies could eventually produce as much as 50 percent improvement in vehicle mileage, which in turn would mean annual energy savings of millions of barrels of oil.

## INSTITUTIONAL/FINANCIAL IMPACTS

Institutional

- o The governmental structure for implementing mobile source control measures already exists in the California Air Resources Board (CARB) which presently has primary responsibility for controlling vehicular emissions in the State. However, specific institutional arrangements for implementing both the inspection/maintenance programs and the heavy duty gasoline retrofit program will be required since none of them are within the current authority of CARB.

  The California Air Resources Board and/or the Bureau of Automotive Repair (BAR) would likely assume responsibility for the regulation and operation of I/M programs. Local governmental agencies involvement is not anticipated. The CARB has had experience with implementing retrofit programs in the past. It is assumed that implementation of the proposed heavy duty gasoline retrofit program would be assumed by CARB.

  Inspection/maintenance (I/M) programs can be directly administered by the State, or franchised out to private contractors. Data from a pilot I/M program currently being operated in the South Coast Air Basin suggests that the operation of such programs might make disproportionate demands on the administrative resources of the State. Therefore, a private-operated/public-monitored program may be preferable for the Bay Area.

Financial

Direct Public Cost of Implementation

- o See Public Costs (a) in the column headed "Total Cost/Yr of Recommended Action."

Fiscal Effect on Local Government

- o No impact.

## ECONOMIC IMPACTS

Production of Goods and Services

- o A slight increase in the production activity of some industries servicing the automobile manufacturing industry might occur as new tooling required to produce newly designed engines is needed. New engine design may stimulate substantial change in the automotive repair and service industry. The implementation of the inspection/maintenance (I/M) measures would add a new line of service for the California automotive service industry. Some services presently exist for identifying defective emission control equipment on cars. They are not, however, universally applicable to all California registered vehicles. I/M programs for light, medium, and heavy duty vehicles would offer a universally applied service program for identification and repair of vehicles with excessive emission caused by maladjusted or defective emission control equipment.

Income and Investment

- o See Private Costs (b) in the column headed "Total Cost/Yr of Recommended Action."

Consumer Expenditures

- o The manufacture of new engine technologies would necessitate an increase in the initial cost of new vehicles. This increase may be offset, however, by savings in operating cost throughout the lifetime of the vehicle. Catalytic converters are estimated to cost about $350.00 per heavy duty vehicle. (Price includes cost of the device and installation charges.) For a light and medium duty vehicle I/M programs an inspection fee of $5-6.00 per vehicle would be required. The average cost of repairs for the catalyst equipped vehicle is about $45.00.

## SOCIAL IMPACTS

Housing Supply

- o No impact.

Physical Mobility

- o Because of increased cost of private transportation, the mobility of the limited income segment of the Bay Area population may be impaired. This would be particularly true for those located in other than urban centers.

Health and Safety

- o These control measures would substantially reduce carbon monoxide emissions from motor vehicles. Therefore, substantial health-related benefits may accrue to those segments of the population that experience the heaviest exposure to carbon monoxide concentrations while residing, working or shopping in urban centers.

Sense of Community

- o No impact.

Equity

- o The measures will adversely impact some groups in urban areas more severely than others--particularly those with limited income.

Urban Pattern

- o No impact.

| RECOMMENDATIONS | DIRECT BENEFITS (Hydrocarbon emission reductions, tons/day) 1985 | 2000 | RESPONSIBLE AGENCY (or agencies) | SCHEDULE FOR ACTION A - Adoption I - Fully Implemented | TOTAL COST/YEAR OF RECOMMENDED ACTION | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|---|

## III. Transportation controls

GENERAL POLICY: REDUCE MOTOR VEHICLE EMISSIONS THROUGH TRANSPORTATION ACTIONS TO REDUCE VEHICLE USE

| RECOMMENDATIONS | 1985 | 2000 | RESPONSIBLE AGENCY (or agencies) | SCHEDULE FOR ACTION | TOTAL COST/YEAR OF RECOMMENDED ACTION | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|---|
| **Action 7**<br>Preferential parking for carpools and vanpools. | 0.1 | Not estimated separately | Cities, counties, employers, MTC. | A - 1978<br>I - 1985 | $886,000[a] | - Federal Aid highway programs<br>- Local Transportation Development Act funds | - Caltrans enabling legislation<br>- Local planning and traffic control enabling legislation |
| **Action 8**<br>Pursue a three-fold transit improvement strategy.<br>(1) MTC, in cooperation with transit operators, will adopt service improvement objectives which can be financed by the existing commitment of resources to transit. Improved capacity, service, and ridership are contemplated. A measure of the improvement expected should be agreed to and committed to in the context of the RTP by October 1, 1978.<br>(2) MTC will continue its efforts to identify the need for additional services (as it has, for example, in the elderly and handicapped program and more recently in the Minority Transportation Needs Assessment Project (MTNAP) and to pursue providing additional services as they are justified. A measure of the improvement expected will continue to be developed as these special needs are examined and as the demand for transit services expands generally.<br>(3) During the commute hours all major transit systems in the Bay Area are at capacity. Any substantial increase in ridership will be dependent upon increased Federal or State financial assistance. The amount of rider- | 1.3 | | MTC, transit districts (e.g., MUNI, AC, BART) | A - 1978<br>I - 1985 | $31 million[a] | - Federal Mass Transportation Assistance Programs<br>- Fare revenues<br>- Local Transportation Development Act Funds<br>- State Highway Trust Fund diversions | - Local Transit District Enabling Legislation<br>- Bay Area Rapid Transit District Enabling Legislation<br>- Interagency Memoranda of Understanding |

[a] Public agency

[b] Private

| ENVIRONMENTAL IMPACTS | INSTITUTIONAL/FINANCIAL IMPACTS | ECONOMIC IMPACTS | SOCIAL IMPACTS |
|---|---|---|---|
| Air Quality<br>o See "Direct Benefits" column.<br><br>Water Quality<br>o No impact.<br><br>Physical Resources<br>o No impact.<br><br>Energy<br>o Gasoline savings from carpooling, the shift to transit, improved traffic flow, and the shift to bicycles.<br>o Minor increase in transit fuel consumption.<br><br>Amenities<br>o Cleaner air. | Institutional<br>o Additional transit service would be provided by the present operators.<br>o Ride sharing programs would be handled by a recently established non-profit corporation.<br>o Caltrans would implement high-occupancy vehicle (HCV) lanes and carpool lots.<br>o Cities and counties would implement bibycle measures. Private employers and businesses would be encouraged to participate.<br><br>Financial<br>o Certain measures, notably the additional transit services, bus/carpool lanes, and bicycle systems, are costly. There is some funding available, but additional funds will be needed. MTC has suggested that the State and Federal governments provice the funding necessary to support the transit improvements. | Production of Goods and Services<br>o New employment in the transit sector.<br><br>Consumer Expenditures<br>o Savings to those commuters utilizing carpools, vanpools or transit. | Housing Supply<br>o No impact.<br><br>Physical Mobility<br>o Additional transit service would increase mobility of all transit users.<br>o Carpool/vanpool measures would increase travel options for most commuters.<br><br>Healtn and Safety<br>o Reduction in auto accidents with improved peak period flow.<br>o Possible increase in number, but not rate, of bicycle accidents with increased usage.<br><br>Sense of Community<br>o No impact.<br><br>Urban Patterns<br>o May encourage a more compact land use pattern, with employees living closer to transit lines and/or their jobs.<br><br>Equity<br>o Measures such as additional transit service will particularly benefit low income, handicapped and other persons who depend on this mode of travel. |

IMPACTS IDENTIFIED ARE FOR
ACTIONS 7, 8, 9, 10, and 11

| RECOMMENDATIONS | DIRECT BENEFITS (Hydrocarbon emission reductions, tons/day) 1985 2000 | RESPONSIBLE AGENCY (or agencies) | SCHEDULE FOR ACTION A - Adoption I - Fully Implemented | TOTAL COST/YEAR OF RECOMMENDED ACTION | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|
| ship increase is directly affected by the amount of increased State and Federal funding. Provision of additional transit capacity represents a positive transportation strategy. Thus the State and Federal governments are encouraged to provide necessary funding support for transit improvements to offset any air quality deficiencies caused by deleting less desirable transportation control measures. Without this financial support, transit capacity cannot be significantly expanded. | | | | | | |
| **Action 9**<br>Support development of high occupancy vehicle lanes and/or ramp metering on selected freeway segments when justified on an individual project basis. | 0.2 Not estimated separately. | Caltrans, transit districts, cities and counties. | A - 1979<br>I - 1990 | $7,438,000[a] | - Federal Aid Highway Programs<br>- State Highway Programs funds | - AB 69 (State Transportation Planning Enabling Legislation)<br>- AB 363 (Bay Region Transportation Planning Legislation)<br>- Caltrans Enabling Legislation<br>- Local Planning and Traffic Control Enabling Legislation |
| **Action 10**<br>Provide more ride sharing services such as jitneys and vanpools. Objectives need to be developed and monitored to gauge the desirable rate of expansion. | 1.7 | Caltrans, employers, MTC | A- Previously adopted<br>I - 1979 | $300,000[a] | - Federal Transportation Funding | |
| **Action 11**<br>Develop more extensive and safe bicycle systems and storage facilities. Objectives need to be developed and monitored to gauge the desirable rate of expansion. | 2.0 | Cities, counties, MTC, Caltrans | A - 1980<br>I - 1985 | $438,000[a] | - Federal Aid Highway Programs<br>- Local Transportation Development Act Funds | - Federal-Aid Highway Legislation<br>- Local Transportation Development Act Legislation |
| **Action 12**<br>MTC is requested to consider the following action: "Complete construction of certain portions of State freeway systems in which there are now pollution-causing gaps." | | MTC | 1978 | 0 | | - MTC enabling legislation |

| ENVIRONMENTAL IMPACTS | INSTITUTIONAL/FINANCIAL IMPACTS | ECONOMIC IMPACTS | SOCIAL IMPACTS |
| --- | --- | --- | --- |

| RECOMMENDATIONS | DIRECT BENEFITS (Hydrocarbon emission reductions, tons/day) 1985 | 2000 | RESPONSIBLE AGENCY (OR AGENCIES) | SCHEDULE FOR ACTION A - Adoption I - Fully Implemented | TOTAL COST/YEAR OF RECOMMENDED ACTION | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|---|

# IV. Other measures

GENERAL POLICY: ENSURE MAINTENANCE OF THE OXIDANT STANDARD BEYOND 1985-87

| RECOMMENDATIONS | 1985 | 2000 | RESPONSIBLE AGENCY (OR AGENCIES) | SCHEDULE FOR ACTION | TOTAL COST/YEAR | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|---|
| **Action 13**<br>Adopt between 1985 and 1987, and implement in 1990 or thereafter, one or more of the following measures to ensure maintenance of the oxidant standard through the year 2000, subject to further evaluation of the measures during the continuing planning process:<br>o Reduce hydrocarbon emissions from small gasoline engines<br>o Reduce hydrocarbon emissions from off-highway mobile sources<br>o Implement more stringent vehicle exhaust emission controls--Approximately 60-80% reduction below 1977 prescribed levels.<br>o Provide additional transit | 0 | 24 | ARB; BAAPCD; ABAG; MTC; transit operators. | A - 1985-87<br>I - 1990-95 | To be determined | To be determined | Clean Air Act, Mulford-Carrell Act |

| ENVIRONMENTAL IMPACTS | INSTITUTIONAL/FINANCIAL IMPACTS | ECONOMIC IMPACTS | SOCIAL IMPACTS |
|---|---|---|---|
| | | | |
| Air Quality<br>o The four measures are estimated to reduce hydrocarbon emissions by 24 tons/day by the year 2000<br>o Localized increases in CO, $NO_x$ and particulates where diesel fuel substitutes for gasoline and as result of increased transit<br>Water Quality<br>o No impacts<br>Physical Resources<br>o Reductions in adverse biological effects on vegetation (trees, shrubs, agricultural crops) from improved air quality<br>Energy<br>o May result in use of alternative fuel sources; less specialized fuels<br>o May require new materials for engine manufacture (e.g batteries for electrically powered vehicles)<br>o Increases in transit would save millions of gallons of gasoline from reduced auto use (e.g. 25% increase would save approximately 29.5-59.5 million gallons of gasoline per year; 50% increase would save approximately 44.5-87.6 million gallons of gasoline per year).<br>o Increases in transit would consume diesel fuel (e.g. 25% increase would consume approximately equivalent of 131,000 barrels crude oil or 5.5 million gallons of gasoline; 50% increase would consume approximately equivalent of 263,000 barrels crude oil or 11 million gallons of gasoline annually<br>Amenities<br>o Air quality improvements would contribute to overall visual quality. | Institutional<br>o Authorities to implement these measures already exist<br>o Institutional mechanisms to carry out these measures already exist<br>Financial<br>o Public costs to implement these measures will be determined during the continuing planning process<br>o Additional transit rolling stock would depend on availability of Federal and State financial assistance. | Production of Goods and Services<br>More stringent vehicle exhaust emission controls may slightly increase production activity of some auto manufacturing service industries. Inspection/maintenance would add new line of service to auto service industry.<br>Additional transit would result in employment. For example a 25% increase would require approximately 855 additional buses; a 50% increase approximately 1710 buses. Assuming one full-time position for each additional bus, the resulting jobs range from 855-1710 new transit driver jobs, plus an uncalculated number of service jobs (e.g. transit mechanics, captains, etc).<br>Income and Investment<br>o Employment benefits will result in total wage and salary increases<br>o Capital investment for transit improvement would require Federal and State financial assistance. Operation and maintenance costs would be financed from system revenues.<br>Consumer Expenditures<br>o New equipment emission standards would add to costs of small gasoline engines (e.g lawnmowers, garden tractors) and off-highway mobile sources (e.g. tractors, graders). Some costs could be kept low by requiring relatively simple control systems (crankcase ventilation for small gasoline engines). Retrofit for off-highway mobile sources may be relatively inexpensive as positive crankcase ventilation (PCV) devices cost little and do not significantly effect performance. Equipment manufacturers are currently working on reducing exhaust emissions; most new equipment being produced with diesel engines and climate enables year round use and more rapid expiration of service life.<br>o More stringent vehicle exhaust emission controls would increase costs of new vehicles but may be offset against savings in operating costs throughout life of vehicle. Example costs: catalytic converter cost estimated at 350 per heavy duty vehicle; I/M fees of \$5-6 per vehicle for light and heavy duty vehicles; average repair for catalyst equipped vehicle \$45 | Housing<br>o no impacts<br>Physical Mobility<br>o Transit improvements would improve the mobility of transit dependent, low-income and individuals in proximity to transit.<br>o Increases in cost of private transportation (associated with increased costs of new vehicles to meet exhaust emission controls) could affect the mobility of individuals dependent on the private auto. May impair the mobility of the limited income segment of the population living in rural areas or areas not serviced by transit.<br>Public Health and Safety<br>o Maintenance of Federal photochemical oxidant standard will have public health benefits for general population and particularly for sensitive populations such as elderly, children and chronically or temporarily ill.<br>o Exhaust controls for small gasoline engines will have localized or individual benefits. Exposure of equipment operators and people in immediate vicinity may be significant especially from 2-stroke engines; health benefits of cleaner engines should be stressed.<br>o See also impacts for transportation measures.<br>Sense of Community<br>o See Physical Mobility and Public Health and Safety<br>Urban Patterns<br>o Same as noted for transportation measures |

# Section-J
# IMPLEMENTATION OF THE OXIDANT PLAN RECOMMENDATIONS

Section I identified a wide range of air quality measures needed to meet and maintain the oxidant standard. An overall implementation schedule for each measure was also presented. This section further details how the plan would be carried out. It describes the roles of different implementing agencies, requirements for new legislation, and requirements set forth by the Clean Air Act of 1977.

## IMPLEMENTING THE PLAN RECOMMENDATIONS

The authority to implement most of the plan recommendations currently exists among the various State, regional and local agencies. In a few instances, new legislation would be required to carry out a few of the proposals. However, to a large extent the plan recommendations build upon existing powers and proposes programs which extend these authorities.

Air pollution controls in the Bay Area have been the primary responsibility of the California Air Resources Board and the Bay Area Air Quality Management District. In the plan, both agencies continue to have very important roles. These two agencies would be responsible for ensuring that available control technologies for stationary and mobile sources are being used. This would apply to existing sources in each case. New sources would also be stringently controlled. The plan also identifies important roles for State and regional agencies and local governments of the Bay Area. Both general and special purpose agencies would be involved. These agencies would be responsible for reducing the amount of automobile travel in the region through transportation improvements. These would help reduce regionwide increases in the length and number of automobile trips made.

Federal agencies also would play an important role in carrying out the plan. As in the past, the Environmental Protection Agency must continue to provide technical assistance. Available control technologies will have to be precisely defined. Important oxidant control issues such as long range transport and the precise role of nitrogen oxides in oxidant formation, need further research.

Federal agencies will also be needed to provide financial assistance. Such support is needed for further planning, monitoring activities, and in some cases to fund implementation of important programs. It is assumed under the Clean Air Act of 1977 that funds for planning and carrying out key air pollution control programs will continue to be granted to California and Bay Area governmental agencies. For example, the Clean Air Act of 1977 may be able to assist states financially in implementing inspection and maintenance programs. Also, if the Bay Area is to significantly improve and expand its transit service, the U.S. Department of Transportation would have to provide additional funds to subsidize operation and maintenance expenses. Other grants would be required to fund the capital costs of the buses and other transit vehicles.

Stationary Source Controls -- The Role of the Bay Area Air Quality Management District

Three basic programs would be carried out by the Bay Area Air Quality Management District. These programs are:

- Use of available control technology (ACT) for existing industries
- Use of technology to produce lowest achievable emission rates for new sources.
- A review (and permit program) for new and modified air pollution sources to ensure use of BACT and a determination of the source's contribution to further violations of air quality standards. The District, as previously noted, has had some form of new source review rule in effect since 1972.

The Bay Area Air Quality Management District has the authority to adopt an ACT rule after public hearings. Adoption of such a regulation requiring industry to use specific control technologies would warrant careful thought and extensive public hearings. The most probable form of such a rule would incorporate available control technology into a permit system, and would work from a catalog listing the best available control methods or equipment in any particular situation. Possibly there would be some flexibility in what methods or equipment would be required to accommodate the wide variety of sizes, forms, design and operations to be found in the many industries affected. The catalog would be regularly reviewed and updated, with a continuing critique provided by the District's Advisory Council.

An available control technology rule could supercede performance standards or be applied in conjunction with performance standards. Minimum performance levels could be used to prevent deterioration of the best available control technology after installation. In some cases, existing performance standards in effect require use of best available control technology.

Implementation of an available control technology rule would require an increase in the District's engineering staff and probably Legal and Hearing Board staff. An additional ten engineers would be needed to carry out the work required by such a rule. It is also expected that the District's Hearing Board activities would increase as a result of such a rule.

An available control technology rule could be adopted by the end of 1979. Five years should be allowed for full implementation. This regulation would cover a wide range of operations within the Bay Area. The rule itself is likely to be controversial and therefore subject to some delays as it is being adopted. Many establishments, for example, may have recently incurred expenses for control equipment that may now be declared obsolete. In the adoption process, the District's Board of Directors could consider exemptions and extended time schedules for classes of industries or small operations. After the rule had been adopted, individual appeals could be made to the District's Hearing Board for variances from the regulation where justified.

In February 1978, the Air District Board considered stationary source control measures in the draft air quality plan. The Board reviewed a report from the district staff and adopted the recommendations contained in the staff report. These recommendations were forwarded to the Environmental Management Task Force and the air quality plan adopted in June 1978 for oxidant reflected the position of the district regarding stationary source controls.

The Clean Air Act Amendments of 1977 require the use of reasonably available control technology--at a minimum--in all areas of the country where the 0.08 ppm oxidant standard is being exceeded. In October 1978, EPA identified reasonably available control technologies (RACTs), also known as control technology guidelines (CTGs) for 12 categories of sources. Controls for additional source categories are forthcoming.

On comparing the EPA-defined RACTs with existing local regulations, the Bay Area Air Quality Management District found that two existing district regulatory requirements are more stringent. Eight BAAQMD regulatory requirements are less stringent than RACT requirements. One source does not exist in the district, and one District regulation is equivalent but needs clarification. A comparison of the RACT requirements with 1978 District regulations is shown in Table 29A. Table 29B is a summary comparison of emission reductions from EPA RACT measures with those attributed to Action 1 - Available Control Technology by source category.

To comply with the 1977 Clean Air Act requirements, the District has set public hearings through March 1979 to consider adoption of proposed rules. Drafts of five regulations covering six CTG categories are included in this section. Draft regulations are being prepared for three other source categories covered by EPA guidelines: cutback asphalt, degreasing and refinery operations. For other source categories not covered by current EPA CTGs, but for which emission reductions have been identified in Action 1, the district plans to adopt and implement regulations on the tentative schedule shown in Table 29B.

## Mobile Source Controls - The Role of the California Air Resources Board

Three programs are recommended for implementation by the California Air Resources Board. These control programs are:

- Adoption of more stringent light and heavy duty exhaust emission standards

- Implementation of a Statewide inspection and maintenance program for light and heavy duty vehicles

- Implementation of a heavy duty gasoline exhaust retrofit device for in-use heavy duty gasoline vehicles Statewide.

The requirement for carrying out these programs are different in each case. These differences are described briefly below.

Section 209(b) of the 1977 Clean Air Act permits California upon request to the Environmental Protection Agency to obtain a waiver from the Federal auto exhaust emission standards. Such a waiver would allow California to adopt more stringent automotive exhaust emission standards. A similar provision was also in the 1970 Clean Air Act because of the particularly

TABLE 29A. COMPARISON OF EPA RACT MEASURES AND BAAQMD REGULATIONS

| | EPA RACT MEASURE | CONTROL REQUIRED | BAAQMD REGULATORY CONTROL | COMMENT |
|---|---|---|---|---|
| 1. | Service Station Phase I (Tank) | 90% | 90% (Reg 2) | No new regulation needed. |
| 2. | Fixed Roof Tanks | Internal Floating Roof | Secondary Seals (Reg 3) | District more restrictive. No new regulation needed. |
| * 3. | Gasoline Bulk Plants (Truck filling) | 95% Vapor Balance | 60% (Reg 3) Proposed Reg 13 | District less restrictive. New regulations needed. |
| * 4. | Gasoline Bulk Terminals | 95% | 95% Proposed Reg 13 | Need to modify Reg. to include smaller terminals and consider spills and leaks. |
| * 5. | Metal Degreasing | 85% Control Overall | 85% if > 40 lb/day<br>0% if < 40 lb/day<br>(Reg 3) | District less restrictive. New regulation needed. |
| 6. | Cut Back Asphalt | No Organics Allowed | Allows 400 lb/ton (Reg 3) | District less restrictive. New regulation needed. |
| * 7. | Auto Body Painting | 70% | 20% (Reg 3) Proposed Reg 17 | District less restrictive. New regulation needed. |
| * 8. | Can Coating<br>Fabric Coating<br>Paper Coating<br>Coil Coating | 50-80% | 20-40% (Reg 3) Proposed Reg 14 and 16 | District less restrictive. New regulation needed. |
| * 9. | Metal Coating | 80% | 20-50% (Reg 3) Proposed Reg 14 | District less restrictive. New regulation needed. |
| *10. | Large Appliance Manufacture | 80% | 20-50% (Reg 3) | District less restrictive. New regulation needed. |
| 11. | Magnet Wire Insulation | 80% | Less than 80% (Reg 3) | District less restrictive (No operations in District) |
| 12. | Refinery:<br>a) Vacuum systems<br>b) Waste water systems<br>c) Process unit turn arounds | Best Modern Practices | Best Modern Practices Proposed Reg 18 | District about the same. Regulations need clarification. |

* Denotes ARB Model Rules adopted or in preparation.

TABLE 29B. COMPARISON OF EPA RACT MEASURES WITH AVAILABLE CONTROL TECHNOLOGY BY SOURCE CATEGORY IN 1985

| EPA RACT MEASURES | BAAQMD SOURCE CATEGORIES (#) | REDUCTION ESTIMATES TONS/DAY (T/D) | | ESTIMATED REGULATION DEVELOPMENT SCHEDULE | |
|---|---|---|---|---|---|
| | | EPA | BAY AREA PLAN | ADOPTED | IMPLEMENTED |
| 1. Service Stations Phase I | #26, 27, 28 Vehicle Fill & Tanks | 27.0* | 0* | 1972 | 1975 |
| 2. Fixed Roof Tanks | #23 Storage & Blending | 14.9 | 14.9 | 1977 | 1978 |
| 3. Gasoline Bulk Plants | #25 Bulk Plants | 6.8 | 6.8 | 1979 | 1980 |
| 4. Gasoline Bulk Terminals | | | | | |
| 5. Metal Degreasing | #35 Degreasers | 35.0 | 35.0 | 1979 | 1981 |
| 6. Cut Back Asphalt | Not in BAAQMD Inventory | 20.5** | 0** | 1980 | 1983 |
| 7. Auto Body Painting | | | | 1979 | 1983-5 |
| 8. Can & Coil Coating Fabric & Paper Coating | #31 & #32 Industrial Coating-- Solvent and Water Base | 38.3 | 38.3 | 1979 | 1981-2 |
| 9. Metal Coating | | | | | |
| 10. Large Appliance Mfg. | | | | | |
| 11. Magnet Wire Insul. | | | | | |
| 12. Refinery | ***#2 is Valve Leaks @ 7.4 T/D; | | | | |
| a) Vacuum System | Vac. Sym.@ 2.5 T/D; A.P.I. @ 3 T/D | | | | |
| b) Wastewater | Load Racks @ 3 T/D; Misc. 1 T/D; | 19.5 | 19.5 | 1979 | 1982 |
| c) Process Unit Turnaround | #3 U/B & Flares @ 2.6 T/D | | | | |
| Subtotal | -- | 162.0 | 114.5 | -- | -- |
| ACTION 1 SOURCE CATEGORIES NOT COVERED BY CURRENT EPA RACT | | | | | |
| A. Other Chemical | #9 | 0 | 2.6 | 1982 | 1983 |
| B. Other Ind/Com | #10 Pulp/Paper; #19 Food/Agri. | 0 | 4.1 | 1982 | 1983 |
| C. Marine Loading | #24 | 0 | 4.6 | 1980 | 1982 |
| D. Solvent & Other Tanks | #29 & #30 | 0 | 7.7 | 1981 | 1982 |
| E. Coml/Dom Coatings | #33 & #34 | 0 | 21.7 | 1980 | 1982-3 |
| F. Dry Cleaners | #36 & #37 | 0 | 13.0 | 1980 | 1982 |
| G. Rubber Fabrication | #38 | 0 | 4.7 | 1981 | 1983 |
| H. Plastic Fabrication | #39 | 0 | 23.0 | 1982 | 1984 |
| I. Printing | #40 | 0 | 9.0 | 1980 | 1982 |
| J. Other Organic Evap. | #41 | 0 | 20.0 | 1981 | 1983 |
| Subtotal Source Categories Not Covered By Current EPA RACT | | 0 | 110.4 | -- | -- |
| TOTAL EPA RACT AND ACTION 1 ACT | | 162 - 27= 135 | 224.9 | | |

* Service Station Phase I Control was completed in the Bay Area prior to EPA guidance. It was not included in Action 1 emission reduction estimates.

** Cut back asphalt was not included in emission inventory and no credit was taken in Action 1. The emission reduction will occur when a new district regulation is implemented.

*** A.P.I. separators; U/B - upset/breakdown

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REGULATION 13

PROPOSED REGULATION
FOR CONTROL OF ORGANIC COMPOUND EMISSIONS
FROM TERMINALS AND BULK PLANTS

100 GENERAL

101 Description: The purpose of this regulation is to limit the emission of organic compounds from operations at terminals and bulk plants.

110 EXEMPTIONS

111 Low Vapor Pressure Materials: This regulation does not apply to loading or delivery of any organic liquid having a true vapor pressure less than 0.10 bar (1.5 psia).

112 Exempt Accounts: The requirements in section 302 do not apply to bulk plants loading only delivery vehicles which deliver exclusively to storage tanks which are exempt from vapor recovery requirements by the provisions of Sections 1302.22-(a), -(c), -(d) or -(e), or 1316-F-8 or F-13 of Reg. 2.

113 Delivery Vehicles: The requirements in section 305 do not apply to delivery vehicles which deliver exclusively to storage tanks which are exempt from vapor recovery requirements by the provisions of Sections 1302.22-(a), -(c), -(d) or -(e) or 1316 F-8 or F-13 of Regulation 2.

114 Unusual Construction Problem: The receiving, storage, and loading of any organic liquid at terminals or bulk plants where the APCO determines severe and unusual construction problems would prevent the installation of required vapor recovery equipment.

200 DEFINITIONS

201 Bulk Plant: An intermediate distributing plant which receives organic liquid; stores it in stationary tanks; loads it into tank trucks for delivery to other bulk plants, service stations or other distribution points; and which has an annual throughput of not more than 19,000 cubic meters (5,000,000 gallons).

202 Organic Compound: Any compound containing carbon and hydrogen, or carbon and hydrogen in combination with any other element.

203 Organic Liquids: All organic compounds which would exist as liquids at actual conditions of use or storage.

204 Submerged Fill Pipe: Any discharge pipe or nozzle which meets either of the following conditions:

204.1 Where the tank is filled from the top, the end of the discharge pipe or nozzle must be submerged when the liquid level is 15 centimeters (6 inches)

from the bottom of the tank.

204.2 Where the tank is filled from the side, the discharge pipe or nozzle must be totally submerged when the liquid level is 46 centimeters (18 inches) from the bottom of the tank.

205 Terminal: A primary distributing plant which receives organic liquid; stores it in stationary tanks; loads it into transportable containers, excluding marine vessels, for delivery to bulk plants, service stations or other distribution points; and which has an annual throughput of more than 19,000 cubic meters (5,000,000 gallons).

206 True Vapor Pressure: The pressure exerted when an organic liquid is in equilibrium with its own vapor. True vapor pressure may be found by referring to the applicable nomograph in American Petroleum Institute Bulletin No. 2517.

300 STANDARDS

301 Terminal Limitations: A person shall not emit into the atmosphere more than 72 grams of organic compounds per cubic meter of organic liquid loaded (0.6 pounds per 1,000 gallons) from loading operations at a terminal.

302 Bulk Plant Limitations: Effective July 1, 1979 a person shall not load any organic liquid from any loading rack at a bulk plant having an annual throughput of more than 3,750 cubic meters (1,000,000 gallons) unless a vapor balance system of at least 90% efficiency, or equivalent system, is properly connected during loading.

303 Small Bulk Plant Limitations: A person shall not load any organic liquid from any loading rack at a bulk plant having an annual throughput of more than 500 cubic meters (130,000 gallons) unless such loading is conducted through a submerged fill pipe or its equivalent.

304 Deliveries to Storage Tanks: A person shall not allow the delivery of any organic liquid to any terminal or bulk plant storage tank having a capacity between 7.6 and 150 cubic meters, inclusive, (2,000 and 40,000 gallons) unless a vapor recovery system of at least 90% efficiency, or an equivalent vapor loss control system, has been properly installed on the storage tank and is properly connected during delivery.

305 Delivery Vehicle Requirements: Any delivery vehicle loaded at a terminal or bulk plant which is subject to the requirements of Sections 301 or 302 shall be equipped to allow proper connection to the vapor recovery system required by that section

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and shall be maintained to be vapor tight and in good working order.

306 Equipment Maintenance: All equipment associated with delivery operations shall be maintained to be vapor tight and in good working order.

307 Operating Practices: Any organic liquid having a true vapor pressure greater than 0.10 bar (1.5 psia) shall not be spilled, discarded in sewers, stored in open containers, or handled in any other manner that would result in evaporation to the atmosphere.

400 ADMINISTRATIVE REQUIREMENTS

401 Any person who needs to install a vapor balance, or equivalent, system to comply with the requirements of this regulation shall comply with the following increments of progress:

401.1 February 1, 1979. Submit to the APCO a final control plan which describes, as a minimum, the steps, including a construction schedule, that will be taken to achieve compliance with such requirements.

401.2 March 1, 1979. Submit a completed application for any Authority to Construct necessary to achieve compliance with such requirements.

401.3 July 1, 1979. Be in compliance with all the requirements of sections 302 and 304.

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REGULATION 14

PROPOSED REGULATION
FOR CONTROL OF VOLATILE ORGANIC COMPOUND
EMISSIONS FROM
METAL CONTAINER AND CLOSURE COATING
AND COIL COATING

100 GENERAL

101 Description: The purpose of this regulation is to reduce emissions of volatile organic compounds from the coating of metal coils, cans, drums, pails, lids and crowns.

200 DEFINITIONS

201 "Coating line" means an operation or process for applying, drying, baking and/or curing surface coatings, together with associated equipment including a coating applicator, flash-off area and oven.

202 "Coil coating" means any coating applied to metal sheet or strips which are then rolled into coils for further industrial or commercial use.

203 "End sealing compound" means a compound which is coated onto can ends and which functions as a gasket when the end is assembled onto the can.

204 "Exterior base coating" means a coating applied to the exterior of a can to provide protection to the metal or to provide background for any lithographic or printing operation.

205 "Interior base coating" means a coating applied to the interior of a can to provide a protective lining between the product and the can.

206 "Interior body spray" means a coating sprayed on the interior of the can body to provide a protective film between the product and the can.

207 "Metal container or clsure coating" means any coating applied to either: the interior or exterior of formed metal cans, drums, pails, lids or crowns; or flat metal sheets which are intended to be formed into cans, drums, pails, lids or crowns.

208 "Overvarnish" means a coating applied directly over a design coating to reduce the coefficient of friction, to provide gloss and to protect the finish against abrasion and corrosion.

209 "Three-piece can side-seam spray" means a coating sprayed on the exterior and/or interior of a welded, cemented or soldered seam to protect the exposed metal.

210 "Two-piece can exterior end coating: means a coating applied to the exterior end of a can to provide protection to the metal.

211 "Volatile organic compounds" (VOC) means any compound of carbon (excluding carbon monoxide, carbonic acid, metallic carbides or carbonates, ammounium carbonate and methane) which would be emitted from a coating during application, curing and drying, as determined by a test method approved by the APCO.

300 STANDARDS

301 Metal Container or Closure Coating Limitation: (Effective January 1, 1982) Except as provided in Section 302, a person shall not apply any metal container or closure coating with a VOC content in excess of the following limits:

| Coating Category | Grams of VOC/liter (lb/gal) of coating applied, excluding water | |
|---|---|---|
| Sheet basecoat (interior and exterior) and overvarnish | 180 | (1.5) |
| Two-piece can exterior basecoat and overvarnish | 250 | (2.1) |
| Interior or exterior body spray; two-piece can exterior end coating | 510 | (4.3) |
| Three-piece can side seam spray | 660 | (5.5) |
| End sealing compound | 440 | (3.7) |

302 Equivalent Control for Metal Container or Closure Coatings: The use of coatings with VOC contents in excess of the limits specified in Section 301 shall be allowed, provided the emission of VOC to the atmosphere from the use of such coatings is reduced to a level which the APCO deems equivalent to the

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use of coatings which comply with those limits.

303 Coil Coating Limitation: (Effective January 1, 1982) Except as provided in Section 304, a person shall not apply any coil coating with a VOC content in excess of 200 grams per liter of coating applied (1.7 lb/gal), excluding water.

304 Equivalent Control for Coil Coating: The requirements of Section 303 shall not apply to a coil coating line from which emissions of VOC to the atmosphere do not exceed 120 grams per liter of coating applied (1.0 lb/gal), excluding water.

400 ADMINISTRATIVE REQUIREMENTS

401 Compliance Schedule: Any person who is subject to the limitations of Section 301, 302, 303 or 304 shall comply with the following increments of progress:

401.1 By July 1, 1980 - Submit a plan to the APCO which describes the methods to be employed to come into compliance with the applicable sections.

401.2 By July 1, 1981 - Submit completed application for any Authority to Construct necessary to come into compliance with the applicable sections.

401.3 By January 1, 1982 - Be in full compliance with the applicable sections.

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PROPOSED REGULATION 16
FOR CONTROL OF VOLATILE ORGANIC COMPOUND EMISSIONS
FROM PAPER, FABRIC AND FILM COATING OPERATIONS

100 GENERAL

101 Description: The purpose of this regulation is to limit emissions of volatile organic compounds from the coating of paper, fabric or films.

110 EXEMPTIONS

111 Small Users: The requirements of Section 301 shall not apply to any coating line which emits less than 6.5 kilograms (14.3 pounds) per day.

112 Air-Dried Coatings: The requirements of Section 301 shall not apply to any coating line which does not apply heat for the purpose of drying and/or curing the coating.

113 Low-Solvent Coatings: The provisions of Section 301 shall not apply to the use of any coating with a VOC content of less than 265 grams per liter of coating applied, excluding water (2.2 pounds per gallon).

200 DEFINITIONS

201 Coating Line: All operations involved in the application and curing and/or drying of paper, fabric or film coatings.

202 Fabric Coating: Any decorative or protective coating or reinforcing material applied on or impregnated into textile fabric or vinyl coated textile fabric or vinyl sheets.

203 Film Coating: Any coating applied in a web coating process on any film substrate other than paper or fabric, including, but not limited to typewriter ribbons, photographic film, magnetic tape and metal foil gift wrap.

204 Paper Coating: Any coating applied on or impregnated into paper, including, but not limited to adhesive tapes and labels, book covers, post cards, office copier paper, drafting paper and pressure sensitive tape.

205 Volatile Organic Compound (VOC): Any compound of carbon (excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and methane) which would be emitted during use, application, curing or drying of a solvent or surface coating, as determined by test methods approved by the APCO.

300 STANDARDS

301 Limitations, Coating Lines: Effective January 17, 1981, a person shall not discharge into the atmosphere more than 120 grams of VOC per liter of coating applied, excluding water (1.0 pound per gallon), from any paper, fabric or film coating line.

302 Storage and Mixing Operations: A person shall not allow any liquid leaks from containers storing organic solvents or from tanks for mixing coatings to be used on any paper, fabric or film coating line. All such containers and tanks shall be covered at all times except when material is being added or removed, or when the tank or container is being cleaned or when the container is empty.

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# PROPOSED REGULATION 17
# FOR CONTROL OF VOLATILE ORGANIC COMPOUND EMISSIONS FROM LIGHT- AND MEDIUM-DUTY MOTOR VEHICLE ASSEMBLY PLANTS

100 GENERAL

101 Description: The purpose of this regulation is to limit emissions of volatile organic compounds from operations at light- and medium-duty motor vehicle assembly plants.

110 Exemption, Miscellaneous Coatings: The requirements of Sections 301 and 302 shall not apply to final repair coating operations or to the use of wheel enamels, anti-rust coatings, trunk coatings, interior coatings, flexible coatings and sealers.

200 DEFINITIONS:

201 Coating Line: That portion of a motor vehicle or motor vehicle component production line where surface coatings are applied to such vehicles or vehicle components.

202 Light- and Medium-Duty Motor Vehicles: All passenger cars, light duty trucks and medium-duty vehicles as defined in Section 1900, Title 13, California Administrative Code.

203 Primer: All coatings under the topcoat.

204 Topcoat: The final coating or series of coatings applied for the purpose of establishing the final color and/or protective surface.

205 Volatile Organic Compound (VOC): Any compound of carbon (excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and methane) which would be emitted during use, application, curing or drying of a solvent or surface coating, as determined by test methods approved by the APCO.

300 STANDARDS

301 Interim Limitations: Any person who applies primer or topcoat to light- or medium-duty vehicles on a coating line shall comply with either sub-section (a) or sub-section (b), below:

(a) After January 1, 1981, primer or topcoat shall not be applied with a VOC content in excess of the following limits:

(i) Primer: Not more than 350 grams per liter of coating, excluding water (2.9 pounds/gallon)

(ii) Topcoat: Not more than 590 grams per liter of coating, excluding water (4.9 pounds/gallon)

(b) After September 1, 1983, primer or topcoat shall not be applied with a VOC content in excess of the following limits:

(i) Primer: Not more than 400 grams per liter of coating, excluding water (3.3 pounds/gallon)

(ii) Topcoat: Not more than 380 grams per liter of coating, excluding water (3.2 pounds/gallon)

302 Primer and Topcoat Limitation: After January 1, 1985, a person shall not apply on any light- or medium-duty vehicle coating line any primer or topcoat with a VOC content in excess of the following limits:

(a) Primer: Not more than 275 grams per liter of coating, excluding water (2.3 pounds/gallon)

(b) Topcoat: Not more than 275 grams per liter of coating, excluding water (2.3 pounds/gallon)

303 Final Repair Coat Limitation: After January 1, 1985, a person shall not apply on any light- or medium-duty vehicle coating line any final repair coat with a VOC content in excess of 590 grams per liter of coating applied, excluding water (4.9 pounds/gallon).

304 Equivalent Compliance Methods: The requirements of Sections 301, 302 or 303 shall not apply to any person who submits and complies with a plan approved by the APCO to achieve control of volatile organic compounds equivalent to compliance with those sections, provided such plan meets the following conditions:

(a) The plan shall require the prior approval of the APCO.

(b) The plan shall be reviewed annually, and periodic status reports shall be submitted with such frequency and containing such information as deemed necessary by the APCO.

(c) The plan shall include methods acceptable to the APCO for determining and demonstrating compliance on a continuing basis.

(d) The plan shall not include credit for emissions reductions required by other regulations or other sections of this requlation.

(e) If any regulation is changed or adopted after the approval of the plan, which requires emission reductions which are included in the plan, a new plan shall be submitted which does not include credit for those reductions.

400 ADMINISTRATIVE REQUIREMENTS

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401 Increments of Progress: Any person who must comply with a requirement of this regulation for which the effective date is later than the date of adoption shall comply with the following increments of progress:

(a) At least one year prior to the effective date: submit a plan to the APCO describing the methods to be used to comply with that requirement.

(b) At least sixty days prior to the effective date: submit a completed application for any Authority to Construct necessary to comply with that requirement.

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REGULATION 18
PROPOSED REGULATION
FOR CONTROL OF VOLATILE ORGANIC COMPOUND
EMISSIONS FROM PETROLEUM REFINERY OPERATIONS

100 GENERAL

101 Description: The purpose of this regulation is to limit the emission of volatile organic compounds from specific operations at petroleum refineries.

110 EXEMPTIONS

111 Storage Vessels: The requirements in sections 303 and 304 do not apply to stationary containers used soley for the storage of any organic liquid.

112 Low Volume Organic Vapor Venting: The requirements in sections 303 and 304 do not apply to the purging of any petroleum refinery process vessel in which the volume of organic gases, measured at 16°Celsius (60°F) and 760 mm of $H_g$ (14.7 psia), to be removed is equal to or less than 10 percent of the vessel volume.

200 DEFINITIONS

201 Standard Conditions: Standard conditions are 16°Celsius (60° Fahrenheit) and 760 mm of $H_g$ (14.7 psia).

202 Vacuum Producing Systems: Vacuum producing systems include, but are not limited to, steam ejectors with contact (barometric) condensers, steam ejectors with surface condensers, and mechanical vacuum pumps.

203 Volatile Organic Compound: Any compound of carbon (excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and methane) that has a true vapor pressure greater than 1.0 mm of $H_g$ at standard conditions.

300 STANDARDS

301 Vacuum Producing Systems: Effective January 1, 1980 a person shall not emit into the atmosphere more than 1400 grams total of organic compounds per hour (3 pounds per hour), including non-con-

densible organic gases and organic gases evaporated from condensed liquids, from all vacuum producing systems together on any process vessel unless the organic emissions have been reduced, in weight, by at least 90 percent.

302 Wastewater Systems:

302.1 Drains and Sewers:

a) All openings in oily-water bearing sewer systems shall be liquid sealed to prevent the emission of volatile organic compounds into the atmosphere.

b) Liquid traps shall be used downstream of process drains to prevent the emission of volatile organic compounds.

c) All vents on wastewater system junction boxes shall be submerged below the surface of any contained liquid.

d) When the hydrocarbon content in the vapor space of wastewater system conduits, culverts, and pipelines exceeds 300 ppm total carbon, these organic vapors must be vented to either a combustion device having a documented efficiency of at least 90 percent by weight or other equipment of equal efficiency.

302.2 Retention Facilities: A person shall not store in an open vessel or pond any liquid that will cause the hydrocarbon concentration in the equilibrium headspace of the confined liquid to exceed 300 ppm total carbon. Such liquids must be stored in closed containers having submerged fill-pipes and liquid-sealed vents.

302.3 Wastewater Separators: The reasonable control of volatile organic compound emissions from primary and secondary wastewater separator basins shall be accomplished by employing one of the following:

a) A solid cover totally enclosing the basin (compartment) liquid contents, with all basin cover openings closed, except when the opening is being used.

b) A floating pontoon or double-deck type cover, designed with closure seals installed and maintained so that gaps between the compartment wall and the seal shall not exceed 0.32 centimeters (1/8 inch) for an accumulative length of 97 percent of the perimeter of the tank, and shall not exceed 1.3 centimeters (1/2 inch) for an accumulative length of the remaining 3 percent of the perimeter of the tank. No gap between the compartment wall and the seal shall exceed 1.3 centimeters (1/2 inch).

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c) A vapor recovery system which reduces the emissions of all hydrocarbon vapors and gases into the atmosphere by at least 90 percent by weight.

d) Other equipment of any efficiency equal to or greater than (a), (b), or (c), if approved by the Air Pollution Control Officer (APCO).

Any gauging and sampling device in the compartment cover shall provide a projection below the liquid surface and shall be equipped with a cover, seal, or lid. The cover shall at all times be in a closed position, with no visible gaps between the cover and compartment, except when the device is in use.

All breathing vents shall be equipped with either pressure/vacuum valves or be liquid-sealed.

302.4 Dissolved Air Flotation (DAF) Units: The control of volatile organic compound emissions from Dissolved Air Flotation (DAF) Units shall be accomplished by employing the control strategies listed in section 302.3, above.

302.5 Wastes Disposal: A person shall not dispose of any wastewater systems' waste by dumping these products into open ponds or by biodegradation in open systems unless the wastes disposed of will not cause the hydrocarbon concentration in the equilibrium headspace of these products to exceed 300 ppm total carbon.

303 Refinery Process Vessel Depressurizing: Effective January 1, 1980 a person shall not vent into the atmosphere any organic compounds resulting from the depressurization of any refinery process vessel. All organic gases from these operations must be vented to either gas recovery or a combustion device having a documented efficiency of at least 90 percent by weight.

304 Refinery Process Vessel Purging: Effective January 1, 1980 a person shall not vent into the atmosphere any organic compounds resulting from the purging of any refinery process vessel, unless the vented gas stream has a concentration of less than 300 ppm total carbon and the vessel's internal pressure is below 1000 mm of $H_g$ (4.6 psig). All organic gases requiring controlled disposal must be vented to either gas recovery or a combustion device having a documented efficiency of at least 90 percent by weight.

400 ADMINISTRATIVE REQUIREMENTS

401 Any person who needs to modify an existing source operation or install new control equipment to comply with the requirements of this regulation shall comply with the following increments of progress:

401.1 May 1, 1979. Submit to the APCO a final control plan which describes, as a minimum, the steps, including a construction schedule, that will be taken to achieve compliance with such requirements.

401.2 July 1, 1979. Submit a completed application for any Authority to Construct necessary to achieve compliance with such requirements.

401.3 January 1, 1980. Be in compliance with all the requirements of this regulation.

severe air pollution problems in California and the need for more stringent controls. The California Air Resources Board has been successful in obtaining such a waiver for adoption of stricter standards. Under the plan recommendation, the California Air Resources Board would again exercise its authority to implement tighter exhaust emission standards than the rest of the country.

Under the 1970 Clean Air Act, only California was permitted to adopt more stringent standards. The 1977 Clean Air Act now permits other states to adopt California's standards where such standards are more stringent than the Federal standards. This provision of the 1977 Act reinforces the importance of California's role in leading the country for requiring the most stringent standards achievable by the automotive industry. In fact, under the 1977 Act, the California Air Resources Board and the Environmental Protection Agency need to work closely to set exhause emission standards that are stringent, but technologically achievable. Clearly, if the Federal government requires tighter controls than those identified in the 1977 Clean Air Act, it will be much easier for California to follow suit. Even without such action, however, it appears quite plausible that a further tightening of light and heavy duty exhaust emission standards for vehicles manufactured after 1990 is possible. Because of the implementation schedule assumed for this measure, the tighter exhaust standards is strictly a maintenance measure. This program would be needed to partially offset the large growth in travel projected for the region by the year 2000.

A Statewide vehicle inspection and maintenance program would require State legislation to be implemented. This program would be carried out by the California Air Resources Board and/or the State Department of Consumer Affairs, Bureau of Automotive Repair. The Clean Air Act of 1977 requires that a specific schedule for implementation of a vehicle inspection and maintenance program be included before any time extensions beyond 1982 are allowed for meeting the oxidant standard. It has been assumed that the 1977 Act requirements will be the primary moving force to getting inspection and maintenance implemented in the Bay Area. This program is important for meeting the oxidant standard by 1985-87 and long term maintenance of the standard thereafter.

Implementation of a heavy duty retrofit program would require new State legislation. Such legislation would include the California Air Resources Board to be designated the appropriate implementing agency for the program. To achieve maximum effectiveness from this program, two factors are important:

- The measure would have to be implemented as soon as possible (and no later than 1985). As older vehicles are replaced the need and effectiveness of this control program diminishes.

- The measure would have to be implemented on a Statewide basis. This would prevent vehicles from being registered outside the Bay Area and thus exempt from the control. This would not solve the problem of vehicles registered outside the State. Since many heavy duty vehicles provide inter-state transport, the enforcement aspects of this program could pose some problems.

The heavy duty vehicle retrofit program would be implemented in two stages. The first stage would be to retrofit all 1971-76 model year vehicles by 1980. The second stage would be to require all 1977-82 heavy duty vehicles to be retrofitted by 1985. This program is primarily an attainment measure. Because of the nature of retrofit programs, only short term benefits are gained. Nonetheless, this program is an important part of the broad-based strategy set forth in the plan.

## Transportation Controls - The Role of the Metropolitan Transportation Commission and Others

The Metropolitan Transportation Commission is responsible for preparing the transportation plan for the region. The Commission adopted the transportation controls for oxidant in March 1978. These were incorporated into the Regional Transportation Plan (RTP) in September 1978. MTC is responsible for coordinating the implementation of each of the transportation controls.

A number of the controls are already being implemented. In accordance with Action 8, the transit improvement strategy, a wide range of transit improvements are programmed in the region's 5-year Transportation Improvement Program (TIP). On the basis of these improvements, each of the transit operators has adopted a ridership target for 1982. The sum of these targets will be sufficient to achieve the 1.3 tons/day reduction in hydrocarbons claimed for this measure (see Section G for documentation of the relationship between ridership increase and hydrocarbon reduction). MTC is also actively seeking other funds for transit improvements not currently scheduled in the TIP.

Action 10, the provision of ride-sharing services, is also in the implementation stage. A non-profit corporation was set up in late 1977, to expand the ride-sharing services which have been provided by Caltrans. This agency is funded by the State Energy Commission, Caltrans District 4 and MTC. Two programs are currently underway. One is a carpool-matching program targeted to specific employers. The second is a vanpooling program where the agency leases vans to the participants. In addition to these efforts, the Golden Gate Bridge, Highway and Transportation District is administering a demonstration program to initiate vanpools from Marin County.

Action 7, the preferential parking program for carpools, is also being implemented. Caltrans operates a number of fringe parking lots for carpool and transit users. These include:

Route 580 at Fruitvale Avenue in Oakland
Route 101 at Route 1 in Marin
Route 24 at Gateway Boulevard in Orinda
Dumbarton Bridge Toll Plaza

Caltrans also has a demonstration program providing carpool parking (approximately 500 spaces) in downtown San Francisco at $10 per month for each space--which is currently in the evaluation phase. Other jurisdictions are also providing preferential carpool parking.

Action 9, the High Occupancy Vehicle Lanes/Ramp Metering, is another program that will be implemented by Caltrans. Caltrans, District 4, prepared a "Program for Preferential Treatment for High-Occupancy Vehicles in the San Francisco Bay Area" in July of 1975. It is anticipated that many of the Non-Interstate Highway Projects listed will be incorporated in the forthcoming TIP (April, 1979). The Interstate Highway Projects are being handled as individual studies. For example, the Route 580 Study, which deals with the section between Castro Valley and the Bay Bridge, is scheduled for completion in the spring 1979. A study of preferential treatment on I-80, between the Carquinez and Bay Bridges, is to begin early in 1979.

Action 11, the bicycle system, will require more time for planning because of the number of agencies involved. Local planning and implementation of bicycle systems will be the responsibility of individual cities, counties, transit operators and others. MTC will develop a framework for the overall system, and then coordinate the development of the local elements into a regional bicycle plan. It is anticipated that the planning will be completed by January 1980, and implementation commitments secured by July 1980.

### Maintenance Measures

Four maintenance measures identified under General Policy IV for adoption between 1985 and 1987 and for implementation in 1990 or thereafter will be further examined during the continuing planning process. Implementation of technological controls on small gasoline engines would be the responsibility of the Air Resources Board. So would emission controls on off-highway mobile sources, and more stringent vehicle emission controls. Additional transit improvements, like those recommended under General Policy III, would be the responsibility of MTC and the transit operators. It is possible that other agencies would have implementation roles for these controls, and this would be examined further during the continuing planning process.

## REQUIREMENTS OF THE CLEAN AIR ACT OF 1977

The planning effort for oxidants was more than a year old when the Clean Air Act of 1977 was signed into law. The 1977 Act sets forth specific requirements for "non-attainment plans". Key requirements are cited below, along with brief discussions of how the requirements relate to the AQMP presented. In particular, the plan provisions required by Section 172(a) relating to actions needed prior to any major construction after July 1, 1979 are:

(1) "be adopted by the state"--this plan has been written for inclusion in a State Implementation Plan.

(2) "implementation of all reasonably available control measures"--although subject to some interpretation, this plan adopts reasonably available control measures for implementation to meet and maintain the oxidant standard.

(3) "require, in the interim, reasonable further progress"--if carried out as proposed, this plan would demonstrate reasonable and steady progress toward the oxidant standard, as described below.

(4) "include a comprehensive, accurate, current inventory of actual emissions from all sources"--this plan contains such an inventory.

(5) "identify and quantify the emissions...allowed...from major new... sources"--such an analysis is described in Section H.

(6) "require permits for...new or modified...sources"--this plan recommends continuation of a New Source Review rule implemented by the Bay Area Air Quality Management District.

(7) "identify and commit the financial and manpower resources necessary to carry out the plan"--the financial and manpower resources needed to carry out the plan have been identified; commitments can only come after the plan has been adopted and approved by the many agencies responsible for carrying it out. This task has been identified for completion early in 1979 (see Section X).

(8) "emission limitations, schedule of compliance"--emission limitations to meet the standard and an implementation schedule have been prepared in this plan.

(9) "evidence public, local government, and State legislative involvement"--these requirements have been partially met during the plan preparation and will be fully met as the plan is reviewed by the Air Resources Board and EPA over the next six months.

(10) "evidence...the necessary requirements...to implement and enforce... the plan"--this section described requirements for implementing the plan, including as necessary identification of new legislation required. Considerable work remains for the continuing planning process to secure all the needed agreements, regulations, ordinances, and statutes necessary to implement and enforce the plan as proposed. (See Section X).

The Clean Air Act of 1977 provides for time extensions beyond 1982 for areas with severe oxidant and/or carbon monoxide problems. The analysis shown in Section H and the implementation time schedules described in this section provide a sound basis for formally requesting a time extension for photochemical oxidants, and such an extension is being requested.

DEMONSTRATION OF REASONABLE FURTHER PROGRESS

The demonstration of reasonable further progress toward the oxidant standard is required as part of the Clean Air Act of 1977 specifications for nonattainment plans. Based on implementation time schedules, the demonstration forms the basis for formally requesting a time extension for attaining the photochemical oxidant standard.

The projected reductions in stationary source organic emissions are shown in Table 30 for the industrial source categories in the BAAQMD baseline inventory. These are grouped into four major categories in Figures 33 and

34 to demonstrate the progress of organic emission reductions from stationary sources as proposed in the plan.

The curves are derived by establishing the total reduction to be obtained by each group by 1985 (see table) and then interpolating the course of each group's progress (between 1975 and 1985) based on the following:

Curve A: An organic solvents regulation is already partially in place but further developments will be made in the regulation.

Curve B: The secondary seal regulation is already in effect. Results from the regulation should develop rapidly and thereafter stabilize.

Curve C: A retrofit RACT regulation has not yet been adopted. However, once it takes effect, results should develop rapidly.

Curve D: A valves and flanges rule has just been adopted. After a short delay, the program should develop rapidly and then stabilize.

Curve E: New source review is not included in the BAAQMD list of reductions but is assigned 64 tons per day in the plan. A straight line projection of emissions reductions was assumed.

In Figure 35 the individual curves are plotted as successive reductions.

The projected course of motor vehicle emission reductions shown in Table 31 and, graphically, in Figure 36, is estimated by assuming that implementation of the inspection/maintenance program and heavy duty truck retrofit program would begin in 1982. A straight line increase in effectiveness of these programs to their originally estimated effectiveness level in 1985 is assumed. Beyond 1985, the slightly increasing rate of effectiveness of the inspection/maintenance program is estimated to be balanced by the slow attrition of retrofitted trucks from the vehicle fleet. The adopted transportation controls are assumed to be of negligible effectiveness prior to 1982, consistent with the schedule for implementation contained in the plan, then assumed to be of linearly increasing effectiveness between 1982 and 1985.

The cumulative course of the control recommendations is shown in Figure 37. This demonstrates the plan's compliance with the requirement for reasonable further progress.

Table 30. Reductions in Organic Emissions vs. Baseline Inventory

Without Further Controls As Developed in the Plan

| Source Category | * | Reductions in 1985 | Source Category | * | Reductions in 1985 |
|---|---|---|---|---|---|
| PETROLEUM REFINING | | | GASOLINE DISTRIBUTION | | |
| 1. Refining Processes | | - | 25. Bulk Plants | B | 6.8 |
| 2. Other Processes | D | 16.9 | 26. Vehicle Filling Stations - Spillage | | - |
| 3. Upsets, Breakdowns, Flaring | D | 2.6 | 27. -Storage Tanks | | - |
| | | | 28. -Filling Vehicle Tanks | | - |
| CHEMICAL | | | | | |
| 4. Nitric Acid | | - | | | |
| 5. Phthalic Anhydride | | - | OTHER ORGANIC COMPOUNDS EVAPORATION | | |
| 6. Sulfur | | - | | | |
| 7. Surfuric Acid | | - | 29. Storage Tanks - Solvent | B | 4.8 |
| 8. Titanium Dioxide | | - | | | |
| 9. Other Chemical | C | 2.6 | 30. -Other Organic Compounds | B | 2.9 |
| OTHER INDUSTRIAL/COMMERCIAL | | | 31. Industrial Coating - Solvent Base | A | 38. |
| 10. Pulp and Paper | C | .4 | | | |
| 11. Metallurgical | | - | 32. -Water Base | A | 0.3 |
| 12. Mineral - Asphaltic Concrete Plants | | - | 33. Coml. & Dom Coating-Solvent Base | A | 19. |
| 13. - Concrete Batching | | - | 34. -Water Base | A | 2.7 |
| 14. - Glass & Related Products Mfg. | | - | 35. Degreasers | C | 35. |
| | | | 36. Dry Cleaners - PERC | C | 13. |
| 15. - Stone, Sand & Gravel | | - | 37. -Other Solvents | | - |
| 16. - Sand Blasting | | - | 38. Rubber Fabrication | C | 4.7 |
| 17. - Other Mineral | | - | 39. Plastic Fabrication | C | 23. |
| 18. Farming Operations | | - | 40. Printing | C | 9. |
| 19. Food/Agric. Processing | C | 3.7 | 41. Other Organics Evaporation | C | 20. |
| 20. Paint Spray Mist | | | | | |
| 21. Wood Products Mfg. | | - | | | |
| 22. Other Industrial/Commercial | | - | COMBUSTION OF FUELS | | |
| | | | 42. Domestic | | |
| PETROLEUM REFINERY EVAPORATION | | | 43. Commercial & Institutional - Gas | | |
| 23. Storage & Blending | B | 14.9 | | | |
| 24. Marine Loading | B | 4.6 | 44. -Oil | | |
| | | | 45. Oil Refineries Ext. Combust - NG | | |
| | | | 46. -Refinery Make Gas | | |
| | | | 47. -Fuel Oil | | |

*

| | | Tons/Day (T/D) |
|---|---|---|
| A = Orgsol | | = 60 |
| B = Secondary Seal | | = 34 |
| C = RACT | | =111.4 |
| D = Valve leaks, vacuum systems, A.P.I. separator, load racks, U/B, flares and misc. | | = 19.5 |
| | | 225. |

Table 31. Motor Vehicle Hydrocarbon Emission Projection

| YEAR | COMPOSITE EMISSION FACTOR[a] | DAILY VEHICLE-MILES -TRAVELLED | HC EMISSIONS (TONS/DAY) BASELINE | LESS CONTROLS[c] |
|---|---|---|---|---|
| 1975 | 6.25 (gms/mi) | 68,608,127 | 472 | 472 |
| 1979 | 4.77 | 75,529,191[b] | 396 | 396 |
| 1980 | 4.22 | 77,259,457[b] | 359 | 359 |
| 1981 | 3.70 | 78,989,723[b] | 322 | 322 |
| 1982 | 3.24 | 80,719,989[b] | 288 | 288 |
| 1983 | 2.84 | 82,450,255[b] | 258 | 240 |
| 1984 | 2.51 | 84,180,521[b] | 233 | 197 |
| 1985 | 2.26 | 85,910,789 | 213 | 158 |
| 1986 | 2.07 | 87,978,592[b] | 201 | 146 |
| 1987 | 1.93 | 90,046,395[b] | 192 | 137 |
| 2000 | 1.60 | 116,927,835 | 205 | 85 |

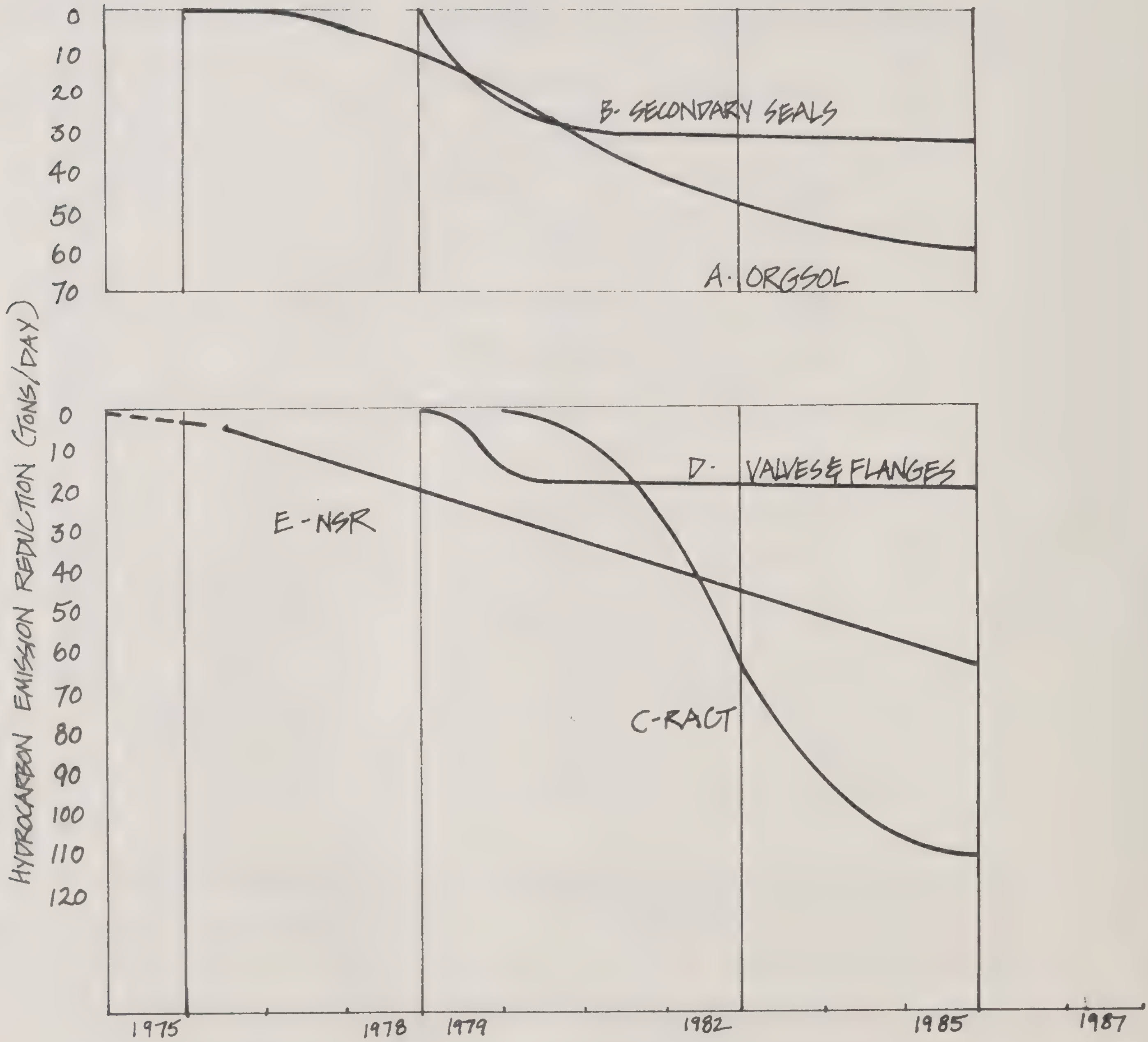
[a] An approximate 32 mph average speed correction was applied to MOBILE-1 emission factor estimates.

[b] Linear interpolation

[c] Actions 5, 6, 7, 8, 9, 10, and 11 in the plan for oxidant (see Table 28).

FIGURES 33, 34

# SCHEDULE FOR STATIONARY ORGANIC EMISSIONS REDUCTIONS




COMPILATION
(YEAR END)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A | ORGSOL | 10 | 20 | 30 | 40 | 48 | 54 | 58 | 60 |
| B | SECONDARY SEAS | 0 | 21 | 29 | 31 | 32 | 33 | 33 | 34 |
| C | RACT | 0 | 0 | 6 | 26 | 62 | 92 | 107 | 111 |
| D | VALVES & FLANGES | 0 | 13 | 18 | 18 | 18 | 19 | 19 | 20 |
| E | NSR | 20 | 26 | 32 | 39 | 45 | 52 | 58 | 64 |
| TOTAL | | 30 | 80 | 115 | 154 | 205 | 250 | 275 | 289 |

FIGURE 35.

CUMULATIVE EFFECT OF AQMP ORGANIC EMISSION CONTROLS VS. "REASONABLE FURTHER PROGRESS - STA. SOURCES."

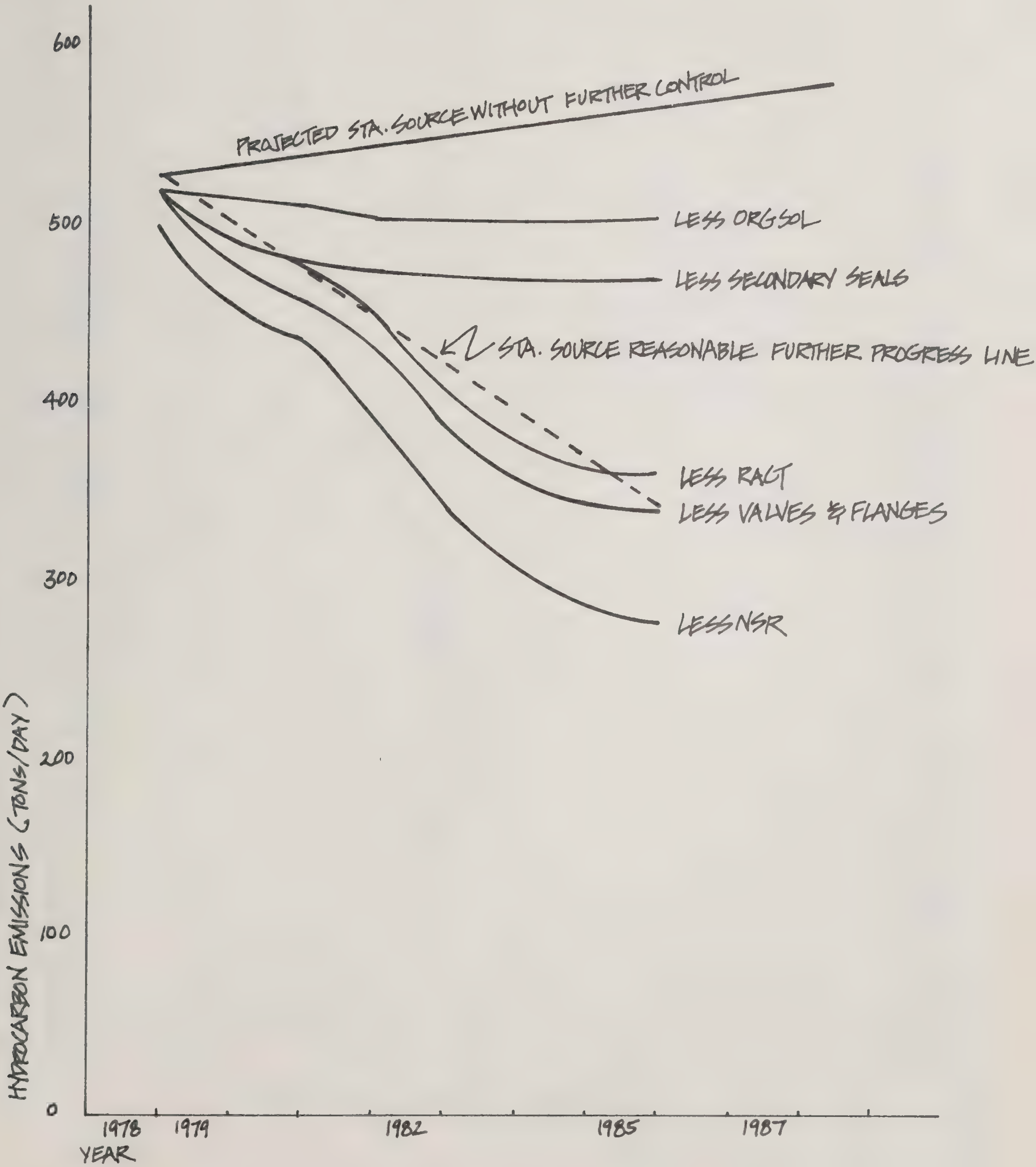
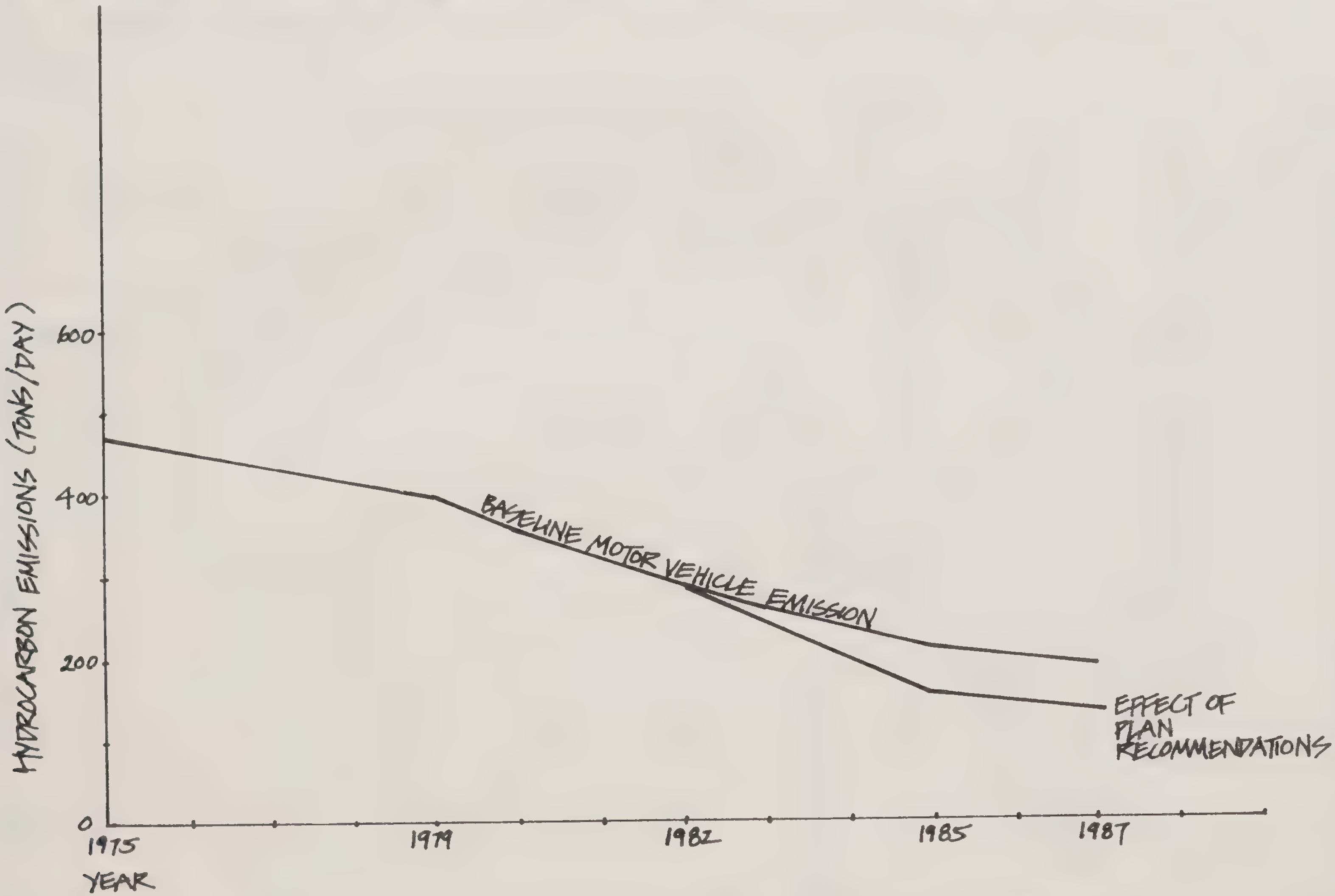


FIGURE 36.

PROJECTED COURSE OF MOTOR VEHICLE HYDROCARBON EMISSION REDUCTIONS.




| CONTROL PROGRAM | EMISSION REDUCTIONS (TONS/DAY) 1983 | 1984 | 1985 |
|---|---|---|---|
| INSPECTION/MAINTENANCE | 7 | 15 | 23 |
| HEAVY DUTY RETROFIT | 8 | 16 | 25 |
| TRANSPORTATION CONTROLS | 3 | 5 | 7 |
| | 18 | 36 | 55 |

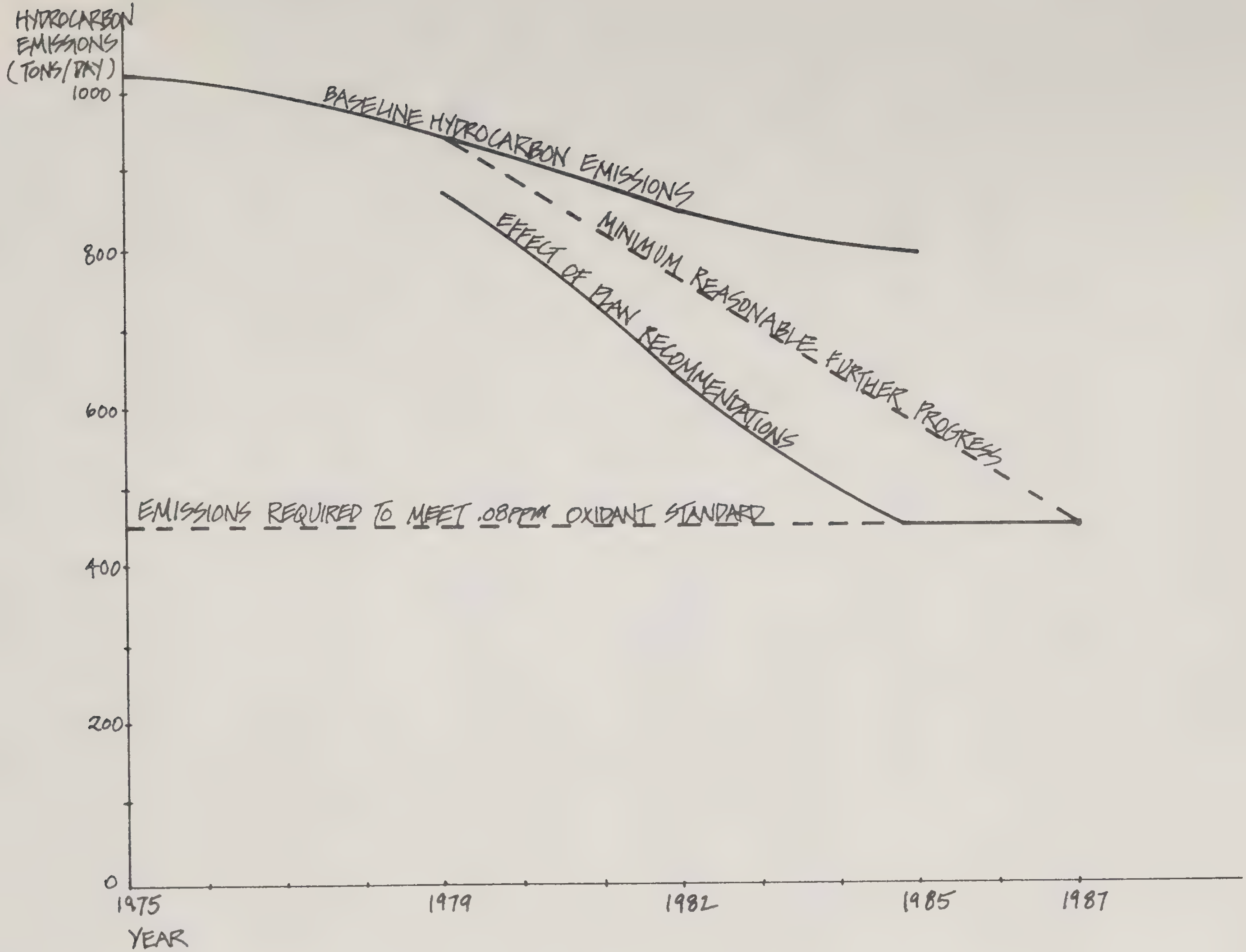



FIGURE 37.

ESTIMATED REASONABLE FURTHER PROGRESS TOWARD ACHIEVING THE .08 ppm OXIDANT STANDARD IN THE SAN FRANCISCO BAY AREA.

# Section-K

# BENEFITS AND COSTS OF THE PLAN FOR OXIDANT CONTROL

This section summarizes the benefits and costs of the air quality plan. As mentioned previously, this portion of the plan (Sections E through N) emphasizes the control of emissions that form photochemical oxidants, the most serious air quality problem in the region. Reducing the concentration of photochemical oxidants has three types of benefits:

- Improvements in public health
- Reduction in damage to vegetation
- Reduction in damage to other materials

The controls required to achieve these benefits will cost money. These direct costs are also summarized in this section. Other effects accompanying the controls have been described in Section I of this chapter.

This section summarizes the latest information on effects. Like other investigations of this nature, there are limitations and uncertainties in the available data. The adverse effects described herein would be significantly reduced or eliminated as this plan is carried out. These improvements constitute, therefore, the benefits of carrying out the plan.

## THE BENEFITS OF CLEANER AIR

Air pollution can have deleterious effects--sometimes very serious effects--on health. Pollution can also damage or destroy plant life and other materials. These adverse effects are set forth below.

### Effects on Human Health

Photochemical oxidants have been found to cause eye irritation, nasal irritation, irritation of mucous membranes, respiratory distress and difficult breathing, increased fluid in the lungs, coughing, rapid pulse rate, lowered blood pressure, asthma attacks, and overall decrease in the quality of human performance.

Some of these effects have been observed at relatively low oxidant levels. In other cases, short-term exposure to relatively high oxidant or ozone levels has produced few if any negative effects. There are two reasons for such variable results. One is that pollution combines with many other factors to affect health. For example, under certain conditions, even low oxidant levels can be harmful. The other reason is that each individual responds differently to oxidant exposure. Thus, the Federal standards for oxidant levels have been set to protect sensitive population groups--and that includes most people at one time or another--children, the elderly, and the chronically or temporarily ill.

A large number of statistical studies, clinical analyses of specific case histories, and controlled experiments have been conducted to determine the effects of photochemical oxidant or ozone exposure. Effects from short-term exposure to high pollutant levels are more easily observed than are effects from long-term exposure to more moderate levels. Following is a brief summary of effects observed in some of these studies. As described in Section D, high levels of oxidant in the region frequently reach 2-3 times (.16 - .24 ppm) the 0.08 ppm standard, depending on meteorological conditions.

- In several American studies, eye irritation has been observed at daily maximum hourly concentrations ranging from about 0.1 ppm to about 0.15 ppm. Recent Japanese studies raise the possibility that even lower oxidant concentrations may contribute to eye irritation under certain conditions. Such values, as previously shown, are quite typical of levels reached in the Bay Area. The consistency of the association between short-term oxidant exposures and eye irritation arouses concern about the long-term effects of such exposures.

- Several studies have noted a gradual decrease in human athletic performance under short-term exposures to photochemical oxidant. Investigators observed that high-school cross country runners did not perform as well when hourly centrations increased from about .03 to .30 ppm. Best performances were almost always on days of low oxidant concentrations. Other similar studies suggest that on high-oxidant days, the irritant effects of pollutants may have restricted the runners' mechanical lung function sufficiently to prevent them from taking in enough oxygen to support their potential performance levels.

- Respiratory distress in healthy people, especially children, has been frequently noted. Symptoms observed in school children, including sore throat, headache, cough and difficult breathing, were higher on days when maximum hourly oxidant levels equalled or exceeded .15 ppm than on days when concentrations were below .10 ppm.

- Short-term oxidant exposure has also been associated with aggravation of existing disease. Thus, individuals with existing respiratory ailments are more likely to be affected by oxidant pollution.

- Investigators have observed a significantly higher rate of asthma attacks on days when oxidant concentrations exceeded .25 ppm.

- A 1973 study measured significant impairment in lung function in 10 normal male subjects aged 23-53 years (including two smokers) exposed to pure ozone at 0.75 ppm for 2 hours. Two of the three subjects who exercised intermittently showed accentuated effects. In other similar experiments, most subjects complained of cough, chest tightness, and soreness. A few also had pharyngitis, difficult breathing and wheezing.

- Some limited studies have shown evidence of human health effects from ozone at concentrations of 0.25 ppm and preliminary findings of a 1976 study suggests lowered lung function at 0.1 ppm exposure for 2 hours.

Additional studies on occupational exposure to ozone are summarized in Table 32. It is evident from the table that a wide range of responses has been observed. Investigators recognize that short-term exposure to high pollutant levels can indicate the potential for serious problems from long-term exposure to moderate or low levels. While specific effects may not be the same in both cases, controlled experiments and clinical appraisals show that exposure to oxidant and ozone concentrations could have serious health effects. Results from a number of controlled human exposure to ozone studies are given in Table 33.

## Effects on Vegetation

Oxidant injury to vegation was first identified in 1944 in the Los Angeles basin. The understanding of oxidant effects and of the widespread nature of their occurence has increased steadily since then. Observed effects on plant life include visible foliar injury and discoloration, increased leaf drop, reduced plant vigor, reduced plant growth, and death.

Biological effects occur not only in individual plants but also in plant communities and entire ecosystems. The implications of oxidant exposure to agricultural crops are dramatic.

- Field experiments compared yields of crops grown in clean air and air with typical ozone concentrations. These experiments showed up to 50% decreases in citrus yield; 10%-15% suppression in grape yield in the first year and 50%-60% reduction over the following two years; and a 5%-29% decrease in yield of cotton lint and seed in California.

- Losses of 50% in some sensitive potato, tobacco and soybean cultivars have been reported in the eastern United States.

- Reductions in yield, with little accompanying injury, have been noted for several crops. Severe injury was required to cause reduction in tomato yield. Chronic exposures to ozone at .05 to .15 ppm for 4 to 6 hours per day produced reductions in yield in soybean and corn grown under field conditions. The threshold concentration for ozone appears to be between .05 and .10 ppm for sensitive plant cultivars.

- Adverse effects of short-term exposure to ozone have been noted at the following levels and durations:

| | |
|---|---|
| Trees and shrubs: | .2 to .51 ppm for 1 hour duration |
| | .2 to .25 ppm for 2 hours duration |
| | .06 to .17 ppm for 4 hours duration |
| Agricultural crops: | .2 to .41 ppm for .5 hour duration |
| | .1 to .25 ppm for 1 hour duration |
| | .04 to .09 ppm for 4 hours duration |

Table 32. SUMMARY OF SELECTED DATA ON OCCUPATIONAL EXPOSURE OF HUMANS TO OZONE

| Ozone, ppm | Subjective compliants | Clinical findings attributed to ozone | Measurements of pulmonary function | Other comments |
|---|---|---|---|---|
| 0.25 | None | None | None | - |
| 0.3 to 0.8 | Chest constriction and throat irritation in 2 to 4 subjects | None | None | - |
| 0.2 | - | None | None | - |
| 0.8 to 1.7 | Dry mouth and throat, irritation of nose and eyes, disagreeable smell in 11 of 14 subjects | None | None | Concentration of trichloroethylene up to 238 ppm found |
| 0.2 to 0.3 | Irritating odor, soreness of eyes, and dryness of mouth, throat, and trachea in 1 of 7 subjects | None | VC decrease in 3 of 7 subjects. FRC decreased in 2 of 7 subjects. $DL_{CO}$ decreased in 1 of 7 subjects. | All decreases in pulmonary function measurements were small. All subjects were smokers. |
| 0.4 | Discomfort and irritation in about 30 minutes | None | None | - |
| 0.47 | Distinct irritation of mucous membranes | None | None | - |

Source: U.S. Environmental Protection Agency, "Air Quality Criteria for Photochemical Oxidants and Oxidant Precursors," Volumes I-II, DRAFT NO. 1, September 1977.

Table 33. SUMMARY OF SELECTED DATA ON HUMAN EXPERIMENTAL EXPOSURE TO OZONE

| Ozone, ppm | Length of exposure | No. and sex of subjects | Subjective complaints | Measurements of pulmonary function | Other comments |
|---|---|---|---|---|---|
| 0.2 | 3 hr/day 6 days/wk, for 12 wk | 6 male | None | VC: no change<br>$FEV_{1.0}$: no change | 0.66 upper respiratory infections/person in 12 weeks. Control group had 0.95 in the same period |
| 0.5 | 3 hr/day 6 days/wk, for 12 wk | 6 male | No irritating symtoms but could detect ozone by smell | VC: slight decrease but not significant decrease toward end of 12 weeks. Returned to normal within 6 weeks after exposure. | 0.80 upper respiratory infections/person in 12 weeks |
| 0.1 | 1 hour | 4 male | | Airway resistance: mean increase 3.3% at 0 hours after exposure (1/4 subjects showed an increase of 45%) | One subject had history of asthma, and experienced hemoptysis 2 days after 1 ppm |
| 0.4 | 1 hour | 4 male | Odor | Airway resistance: mean increase 3.5% at 0 hours after exposure (1/4 subjects showed an increase 12.5% 1 hour after exposure | |

Table 33. (Continued) SUMMARY OF SELECTED DATA ON HUMAN EXPERIMENTAL EXPOSURE TO OZONE

| Ozone, ppm | Length of exposure | No. and sex of subjects | Subjective complaints | Measurements of pulmonary function | Other comments |
|---|---|---|---|---|---|
| 0.6 | 1 hour | 4 male | Odor | Airway resistance: mean increase 5.8% at 0 hour after exposure (1/4 subjects showed an increase of 75%), mean increase 5% 1 hour after exposure | |

<u>Source</u>: U.S. Environmental Protection Agency, "Air Quality Criteria for Photochemical Oxidants and Oxidant Precursors," Volumes I-II, DRAFT NO. 1, September 1977.

- According to a 1975 report by the State Department of Food and Agriculture, certain crops are no longer grown in the Bay Area because of air pollution. Among these crops are snap dragons and chrysanthemums.

- In the Bay Area ornamental growers have relocated their greenhouses from San Francisco to Half Moon Bay. Similarly, rose growers have moved to Salinas to avoid air pollution damage.

- According to recent surveys by the State Department of Food and Agriculture, crops seriously damaged in the Bay Area are grapes, carnations, and orchids.

- Estimated loss to cut flower growers in the Bay Area in 1970 was approximately $1 million.

- Estimates of total annual statewide agricultural damage from air pollution have ranged widely from tens of millions of dollars to almost a half billion dollars. While much of this damage occurs in the Los Angeles and San Joaquin Valley areas, a significant portion also occurs in the Bay Area.

- The available data would suggest annual agricultural damage in the Bay Area from oxidant air pollution may range from several million dollars upwards to tens of millions of dollars.

It is clear that trees, shrubs and agricultural crops are affected by the levels of oxidant air pollution which occur in the Bay Area. It can therefore be concluded that a reduction in oxidant levels can have a very significant beneficial effect on plant life.

Effects on Materials

Just as with humans or plant life, air pollution can have negative effects on man-made materials. Ozone can accelerate the aging of rubber products and can cause dye fading in clothes, carpeting and other textiles. It can reduce the life of industrial maintenance points and vinyl and acrylic coil coatings. Textile fibers can also be damaged by ozone, resulting in accelerated aging.

The cost of such materials damage takes two forms. There is the cost to the producer who must take preventive measures to protect the product from ozone damage. There is also the costs to consumers. The consumer pays for such damage through earlier replacement of materials. For example, one study estimated the national cost of ozone fading--e.g. nylon carpets, permanent-press garments, acetate and triacetate textiles--to be approximately $80 million annually.

Figure 38 presents a summary of the estimated total annual per capita cost of ozone damage and preventive measures as a function of annual ozone concentrations. In 1974, the annual average ozone concentration in the Bay Area was between .015 and .025 ppm. Thus, Bay Area residents paid between $10 and $33 million as a result of ozone damage to materials that year. By the year 2000, all other factors being equal, that cost will have risen to between $12 and $39 million per year in 1975 dollars.

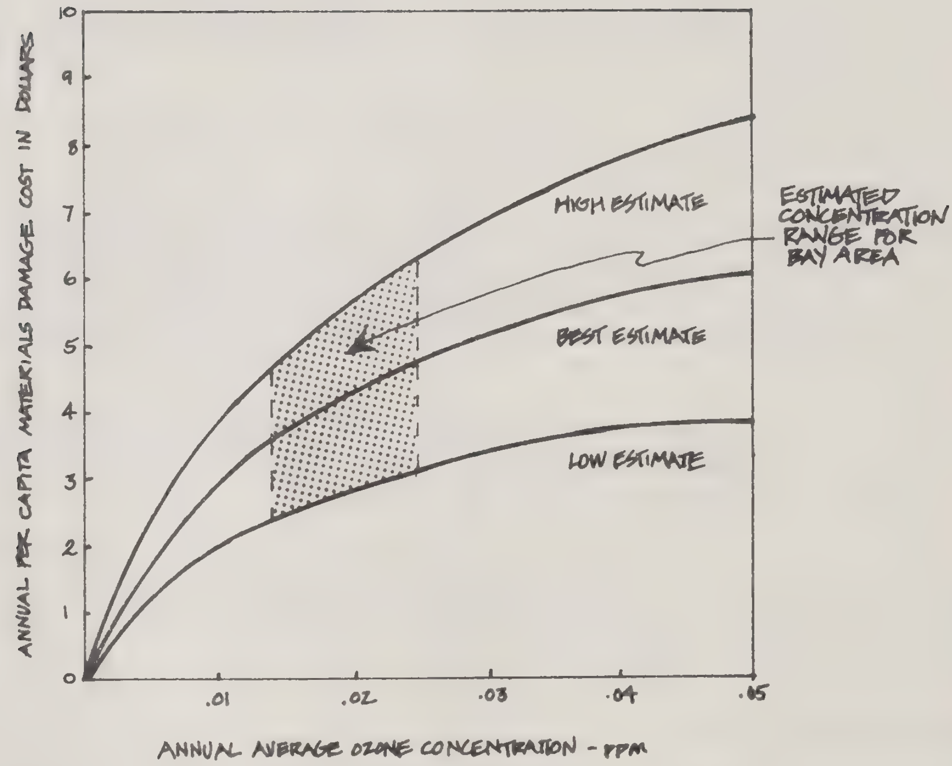



FIGURE 38.

EFFECT OF ANNUAL AVERAGE OZONE CONCENTRATION ON ADDED COSTS DUE TO DAMAGE TO MATERIALS AND PREVENTIVE MEASURES

The benefits to be realized from a significant reduction in oxidant levels may not always be quantifiable, but they are clear nevertheless. Air pollution has been found to have significant and negative effects on human health, plant life and materials. Maintenance of air quality standards thus plays a critical role in reducing the damages now experienced.

## THE DIRECT COSTS OF THE PLAN

Section I of this chapter describes the plan proposals for meeting the oxidant standard. A summary of the annualized costs for the control measures was also included. These costs have been broken down to capital, operation and maintenance, and administrative/regulatory costs. Several programs would generate revenues to offset the costs of other proposals. These have been noted. Details explaining how the annualized cost estimates were derived are given in Section M. This section briefly summarizes the direct costs needed to carry out the plan.

### Stationary Source Control Costs

The major cost for additional stationary source controls would be for meeting best available control technology requirements. It is estimated this would cost about $18 million annually. Most costs would be borne by private industry for capital outlays and higher operating and maintenance costs. An increase in public sector expenditures is also estimated for increased administrative and regulatory costs. These latter costs are estimated to be about three percent (or approximately $530,000) of the costs of this program.

For private industry, slightly more than half of the costs are increased operating and maintenance expenses, which are recurring costs. The capital outlay requirements of approximately two hundred million dollars would be expended in the early 1980s if the plan were carried out as scheduled.

No direct costs are associated with continued implementation of the New Source Review rule. It is acknowledged this program will mean increased cost to industry for emission offset purchases. Since a form of this regulation has been in effect for a number of years, the administrative and regulatory costs are already budgeted for by the Bay Area Air Quality Management District.

### Mobile Source Control Costs

The annualized costs for additional mobile source controls is approximately $50 million for the Bay Area. These costs would pay for three different programs. About half of the $50 million is estimated to be the added per vehicle costs for cars and trucks which meet more stringent exhaust emission standards. The additional cost per vehicle would likely range between $200 and $400, assuming that a new engine technology is used to meet both the more stringent emission standards and Federal fuel economy standards. It has been assumed that these cars would be produced for all of California at a miminum, and possibly in a few other states with severe air pollution.

The vehicle inspection and maintenance program would cost about $20 million annually. This cost includes a $5 per vehicle inspection fee and an average repair cost of $45 per vehicle, both paid by the vehicle owner. The $5 inspection fee will cover the costs of acquiring land, constructing inspection facilities, equipment, and operation of the facilities. An additional aspect of the progarm would be that no vehicle owner would be required to spend more than a given amount (e.g., $75) on repairs related to emission control.

The retrofit of heavy-duty gasoline powered trucks with exhaust catalysts is estimated to cost $340 per vehicle, or a total annualized expenditure of $1.5 million for the region. This cost includes a 50,000 mile replacement warranty. The slight increase in operating cost due to the use of unleaded gasoline will be offset by a slight improvement in fuel economy.

### Transportation Control Costs

Costs associated with the transportation control recommendations are more complex than the costs for stationary and motor vehicle emission controls. In many cases a redistribution of money within the region is the net result. There are many hidden subsidies given to the use of the private automobile including a variety of public services (judicial system, coroner, fire department, on street parking, city planning, and other services typically financed from property taxes), and local ordinances which require parking to be provided by residential, commercial, and industrial developments. Because these subsidies are not structured on a "user pays" basis, there are existing inequities in the way transportation systems are financed. The current use of bridge tolls to support transit service improvements could be viewed as a redistribution of subsidies from one transportation system to another. Increased transit service as proposed by this plan for the period to 2000 is estimated to cost $31 million annually, paid for, in substantial part, by additional Federal and State operating assistance. Additional transit service might be needed for maintenance of the standard after 1990.

The costs associated with the carpool incentive programs (preferential) parking, bus/carpool lanes on freeways with ramp metering, and an expanded carpool matching program) total about $9 million annually. The bulk of these costs are due to construction requirements for the bus/carpool lanes and ramp meters.

Finally, the cost of implementing a comprehensive system of bicycle paths and storage facilities is estimated to be approximately one-half million dollars per year. It was assumed that the paths would be striped onto existing roadways where the additional road width required would be accommodated by narrowing existing vehicle lanes.

### Cost-Effectiveness of Plan Recommendations

The cost-effectiveness of the various plan recommendations can be generally estimated in terms of the cost per ton of hydrocarbon emissions prevented, as summarized below:

- The stationary source control recommendations would cost between $200 and $1000 per ton of hydrocarbon emission reduced, depending on the cost assumptions employed.*

---

*According to the cost conventions used for all control measures and described in Section M, the cost-effectiveness of stationary source controls would range from $200 to $300 per ton. However, stationary source control costs are (1) heavily weighted toward capital outlays for control facilities, which (2) have a shorter useful lifetime than assumed for all control measures (10-15 years rather than 25 years). Using these latter assumptions, the cost-effectiveness would be approximately $1000 per ton.

- The motor vehicle emission control recommendations would cost approximately $1000 per ton of hydrocarbon emissions reduced.

- The transportation recommendations would cost approximately $20,000 per ton of hydrocarbon emissions reduced.

These estimates would indicate to some what the priority for implementation of the various recommendations should be. Stationary source controls are clearly the most cost-effective within the time frame of this plan. The land use and transportation recommendations would appear to be relatively expensive; however, this conclusion is also only valid during the time frame of this plan. The effectiveness of implementing transportation recommendations is expected to increase with time beyond the year 2000.

Section-L

# BIBLIOGRAPHY OF TECHNICAL MATERIALS FOR OXIDANT CONTROL

In the course of developing the Air Quality Maintenance Plan, numerous documents were written to describe the many issues and technical aspects of the plan. These have taken several forms:

- historical/background information
- technical memoranda
- issue papers
- briefs
- other technical support materials

Background reports describe the history of air quality planning in the Bay Area and the role of the AQMP covering oxidants in this context. Technical Memoranda generally focus on a single topic and contain the assumptions and methodology for deriving quantitative information, e.g., emissions inventories, costs, control measure effectiveness. Issue papers contain discussions of issues for which there are several plausible alternative options. Where appropriate, these papers describe the reasoning behind the final, selected course of action. Briefs are status reports concerning the progress of the technical work written in popular language for the benefit of the general public. A variety of technical support materials relevant to plan development were obtained from other ABAG planning programs and/or other agency research efforts.

## BACKGROUND

- "Summary of the Air Quality Maintenance Plan Work Program for the Bay Area Joint Technical Staff," November 1976.

  This report describes the background, objectives and schedule for development of the Air Quality Maintenance Plan (AQMP). A joint air quality planning team with representatives from the appropriate regional agencies will perform the tasks of prediction and analysis, impact assessment, plan formulation and technical assistance in plan adoption process.

- "History of Air Quality Planning in the Bay Area," February, 1976.

  This report describes the development of governmental agencies and programs to deal with the air quality problems of the Bay Area. The Bay Area Air Pollution Control District is the local agency with direct control over polluting activities (primarily

stationary sources). The California Air Resources Board was established in 1967 to deal with the state's air pollution problem. Transportation Control Plans for reduction of auto-related pollutants are developed by the Metropolitan Transportation Commission (for the Bay Area only). In May, 1975 the Association of Bay Area Governments was designated as the lead agency to develop an areawide waste treatment management plan under section 208 of the Federal Water Pollution Control Act Amendments of 1972. This plan encompasses air quality as well as water resources and solid waste planning.

AQMP/TECHNICAL MEMORANDA

- Air Quality Maintenance Plan Technical Memorandum 1, - "Base Year Selection and Technical Assumptions," September, 1976.

  This report describes the base year selection process, and the technical assumptions for developing the stationary and mobile source inventories and the air quality model.

- Technical Memorandum 2, - "Projections/Forecasting: System Description and Technical Assumptions," December 1976.

  This memorandum describes the air quality forecasting system which consists of three primary components: a) population, housing, employment and land use modeling system b) a travel demand modeling system and c) two air quality models (LIRAQ and Larsen).

- Technical Memorandum 3, - "Air Quality Past and Present," March, 1977.

  This report presents a broad, regional perspective of the air quality problem. Annual summary maps based on 1975 data show the geographic variation of the five major pollutants and serve to identify the problem areas.

- Technical Memorandum 4, - "Status of Existing Controls Related to Air Pollution," March 1977.

  This report summarizes the existing stationary source controls, motor vehicle emissions controls and transportation controls related to air pollution. Land use controls are also discussed although the relationship of policy to air quality is not clearly defined.

- Technical Memorandum 5, - "Candidate Control Measures," April 1977.

  This report builds on Technical Memorandum 4 and presents a wide range of candidate controls for achieving air quality standards.

- Technical Memorandum 6, - "The AQMP: Legal Requirements," July, 1977.

  Federal Clean Air legislation requires that air quality maintenance plans be developed for areas expected to exceed the National Ambient Air Quality Standards. This report briefly highlights the substantive and procedural regulatory requirements needed for an AQMP in the San Francisco Bay Area.

- Technical Memorandum 7, - "Development and Analysis of Alternative Air Quality Strategies," July 1977.

  This report describes the way in which air quality strategies, which are comprised of combinations of candidate control measures, are modeled via the forecasting system described in Technical Memorandum 2.

- Technical Memorandum 8, - "Summary of the Technological Forecast for Motor Vehicle Emission Control," July 1977.

  The results of a technology questionnaire on future developments in vehicle emission controls are presented in this report, along with the consequent planning assumptions for modeling future vehicle emissions.

- Technical Memorandum 9, - "Summary of Technology Forecast for Organic Solvents Emissions," July 1977.

  The results of a technology forecast questionnaire on the decreasing use of organic solvents in surface coating operations are presented in this report. Predictions on organic solvent content in the future and the nature of the new technologies are given.

- Technical Memorandum 10, - "Summary of Technology Forecast Questionnaire: Combustion Sources," August 1977.

  This report gives the results of a technology forecast on the status of combustion emissions control e.g., fuel desulfurization, flue gas desulfurization, ammonia injection, combustion modification. It also presents up-to-date estimates of control efficiencies and costs.

- Technical Memorandum 11, - "Present and Projected Air Pollution Emissions in the San Francisco Bay Region," August 1977.

  This report identifies the significant sources of five major air pollutants in the Bay Region in order to provide direction for efforts to control emissions. Emission inventories have been compiled for 1975, 1985 and 2000. The most significant source categories are organic compounds evaporation (HC), light and heavy duty vehicles (HC, $NO_x$, CO) and stationary source fuel combustion ($NO_x$, $SO_x$). There exists some difficulty in identifying the sources of particulate emissions - a significant unknown amount, is from windblown dust and secondary organics (photochemical aerosol).

- Technical Memorandum 12 - "Baseline Motor Vehicle Emission Inventory: Methodology and Results," August, 1977.

  This report describes the methodology for calculating present and projected pollutant emissions from motor vehicles in the Bay Region. The methodology is designed not only to compute total daily emissions but also to distribute the emissions geographically and by hour of the day.

- Technical Memorandum 13, - "Benefits of Photochemical Oxidant Control," December, 1977.

  The benefits to be gained from additional control of photochemical oxidants are described. These benefits are gained in three general areas: improvements in public health; reduction in damage to vegetation; and reduction in damage to other materials.

- Technical Memorandum 14, - "Effectiveness and Costs of Alternative Air Pollution Control Programs," September, 1977

  This report presents the estimated costs and effectiveness of the proposed air pollution control measures. Key assumptions in the method of implementation, the timing and the estimation methodologies are given.

- Technical Memorandum 15, - "Assessment of Alternative Air Pollution Control Programs," January, 1978.

  This report summarizes the effects of the AQMP in sixteen impact areas such as physical resources, equity, mobility and energy.

- Technical Memorandum 16, - "Institutional, Legal and Financial Requirements for Implementing Proposed Air Pollution Control Programs," September, 1977.

  This report discusses the roles of the various participating agencies (Bay Area Air Pollution Control District, Association of Bay Area Governments, Metropolitan Transportation Commission, Department of Transportation) in the AQMP Program. Institutional structures needed to implement the majority of the proposed AQMP actions are in existence. The need for new legislation is minimal. Greater emphasis will be necessary on structuring the institutional arrangements for implementing the transportation and land use programs.

- Technical Memorandum 17, - "Baseline LIRAQ Air Quality Projections," September 1977.

  Includes a description of baseline LIRAQ simulations. Meteorological and emission inventory input files are described along with a summary of the model results for 1975 verification analysis and 1985 and 2000 projections assuming existing growth trends and controls.

- Technical Memorandum 18, - "LIRAQ Emissions Sensitivity Analysis," September 1977.

  Documents the procedures, assumptions and results of varying emissions on air quality projections. The objective was to provide clues to the design of control strategies and to address the issue of the degree of control needed to attain the oxidant standard.

- Technical Memorandum 19, - "Applicability of Selected Statistical/Empirical Techniques to Air Quality Analysis in the San Francisco Bay Region," September 1977.

  Documents the procedures and results of attempts to apply the well-known Larsen Model and the recently developed EPA ozone isopleth technique (also known as the Empirical Kinetic Modeling Approach, EKMA) to the Bay Area. The Larsen Model was found to be generally applicable except for a few cases, while the isopleth technique was found not be be applicable based on a limited sample of Bay Area monitoring data.

- Technical Memorandum 20, - "Procedure for Interpretation of LIRAQ Air Quality Projections," September 1977.

  Problems and techniques employed to relate LIRAQ projections to the ambient air quality standard for oxidants are summarized. Adjustment factors are derived for application to the regionwide high hour oxidant level forecasted by the model to account for worst case conditions and imperfect validations. Limitations of LIRAQ grid coverage are also discussed.

- Technical Memorandum 21, - "Geographical Distribution of Emissions from Non-Major Point (Area) Sources," October 1977.

  This memorandum describes the process and data used to characterize the spatial distribution of stationary area source emissions for LIRAQ modeling purposes. The cross-classification approach which was used is presented.

- Technical Memorandum 22, - "Regional Travel Projections for AQMP," November 1977.

  This memorandum describes the methodology employed in preparing the regional motor vehicle travel projections used in developing the AQMP. A summary of vehicle miles travelled and vehicle trips for each case analyzed is also included with a discussion of the results.

- Technical Memorandum 23, - "Evaluation of Transportation Control Measures," November 1977.

  This memorandum presents the methodology for evaluating and screening transportation control measures, as well as the results of the screening. Each alternative control measure is described and its potential effectiveness in reducing emissions is presented.

- Technical Memorandum 24, - "Analysis of Suspended Particulate Matter in the San Francisco Bay Region," November 1977.

  This memorandum describes the results of applying a chemical mass balance technique for identifying source-receptor relationships for suspended particulate matter in the region.

- Technical Memorandum 25, - "Evaluation of the Transportation System Needs in the Compact Land Use Alternative," January 1978.

  This memorandum investigates the long-range highway and transit needs implication of the draft AQMP proposal to allocate much of the future growth in employment to the northern counties of the Bay Area.

AQMP/ISSUE PAPERS

- Issue Paper 1, - "Air Quality Modeling for the San Francisco Bay Region," September 1976.

  This paper describes the selection of the appropriate air quality models for developing the AQMP. It describes the physical factors for model selection, the alternative models available, the criteria for model selection, and the recommended models. A description of the Lawrence Livermore Lab Regional Air Quality Model (LIRAQ) is included.

- Issue Paper 2, - "The Air Quality Modeling Process: Accuracy and Related Issues," May 1977.

  This paper describes the process by which air quality models will be applied and interpreted in the AQMP. The main focus is on photochemical oxidant modeling since it presents the most severe problem in terms of modeling difficulties and anticipated control requirements.

- Issue Paper 3, - "Regional/Local Issues in Land Use Controls for Improving Air Quality."

  This paper reviews the process by which land use controls have been examined in the AQMP. It presents the complete testing of land use control measures, the pertinent local, regional and state agencies having responsibility for each action and the effects of these measures on such criteria as projected auto travel, the acreage of developed land and transit usage.

AQMP BRIEFS

- Environmental Management Program, "Air Quality Maintenance Plan Brief No. 1 - The Goal, Future Decisions, Issues and Organization," March 1977.

  Brief No. 1 describes the goal, key issues and program organization of AQMP. The goal is stated as being the attainment and maintenance of State and Federal air quality standards as expeditiously as practicable. The Statement of Issues seeks to resolve the differences between the State and Federal standards, to identify appropriate level of governmental responsibility for air pollution controls and to establish a schedule for delivery of the final product.

- "Air Quality Maintenance Plan Brief No. 2 - Alternative Air Quality Strategies," June 1977.

  This Brief describes the existing air pollution control strategies, the candidate control measures, the format of the final product, and the progress and schedule.

- "Air Quality Maintenance Plan Brief No. 3 - Air Quality Problems," August 1977.

  Brief No. 3 describes the past, present and future air quality problems in the Bay Area. The future air quality is projected assuming no additional control programs beyond those currently adopted. A preliminary estimate of the air pollutant emissions reduction required to achieve the program goal is given, along with an updated view of the final product.

- "Air Quality Maintenance Plan Brief No. 4 - Progress Report on Development of the Air Quality Maintenance Plan," October 12, 1977.

  Brief No. 4 describes three key aspects of the AQMP: (1) Results of photochemical oxidant modeling activities conducted to date; (2) Requirements for meeting the 0.08 ppm Federal oxidant standard; and (3) Considerations for dealing with technical uncertainty.

OTHER TECHNICAL SUPPORT MATERIALS

- Association of Bay Area Governments, "Economic and Air Quality Impacts of New Source Review Regulations in the San Francisco Bay Area," prepared for the Bay Area Air Pollution Control District Board of Directors, November, 1977.

  The purpose of this study is to assess the major impacts of alternative new source review regulations. The Air Pollution Control District staff prepared 12 possible changes in the new source review rule as currently embodied in BAAPCD Regulation 2, Section 1309.

  Since the start of the study the Environmental Protection Agency has issued guidelines for new source review regulations, including emission offset policies. Interpretation of the guidelines would seem to preclude some of the alternatives. Yet the systematic examination of all the alternatives provided an important comparison of the effects of each option.

- Barton-Aschman Associates, Inc., "Sensitivity Analysis of Selected Control Measures: Potential Reductions in Regional Vehicle Miles of Travel," Memorandum #1 to the Metropolitan Transportation Commission, July 22, 1977.

The results of a mode-split sensitivity analysis conducted for 13 different transportation control strategies in the San Francisco Bay Area are described. Forecasts of 1985 mode-split changes for auto, transit, and shared-ride trips from the proposed strategies are estimated. Only home-based work trips were examined to obtain a sample of origin-destination districts across the region. Five different origin districts were identified, and trip interchanges between these districts and the San Francisco central business district (CBD), as well as an Oakland industrial area, were investigated. These two destinations were meant to represent CBD and non-CBD trips, respectively.

- Barton-Aschman Associates, Inc., "Sensitivity Analysis of Selected Transportation Control Measures: Potential Reductions in Regional Vehicle Miles of Travel," Memorandum #2 to the Metropolitan Transportation Commission, August 12, 1977.

  A continuation of the work described in the July 22, 1977 memorandum cited above is reported. Potential changes in mode-split for auto, transit, and shared-ride trips identified in the July 22 memorandum are converted to an estimated range of impacts at the regional level. Elasticities of nine of the 13 individual transportation control strategies were plotted and normalized effectiveness indices are computed, for each of the three modes for CBD and non-CBD travel. Relative changes in each of nine transportation control strategies are reported. In addition, four combination transportation control strategies were also tested for their effect on mode choice for CBD and non-CBD trips.

- Bay Area Air Pollution Control District, "Emission Inventory Impact and Cost of Implementation of Proposed Stationary Source Controls," prepared for AQMP Joint Technical Staff by BAAPCD, August 14, 1976.

  The report describes the potential emissions reductions from certain industrial categories that can be expected from a number of stationary source control options. These measures, four of which are recommended in the AQMP for stationary source emission controls, are described separately in the report. Estimated costs for the measures are also presented.

- Bay Area Air Pollution Control District, "Method of Projection," (Draft), May 31, 1977.

  This report contains the Air Pollution Control District staff's methodology for estimating stationary source and aircraft emissions for the years 1975, 1985, and 2000.

- Bay Area Air Pollution Control District, "Emission Inventory Summary Report," August 18, 1976.

  This document contains the Air Pollution Control District staff's estimates of stationary source and aircraft emissions for the years 1975, 1985, and 2000.

- W. Duewer, "Suggested Revision of the LIRAQ Hydrocarbon Emissions Inventory," Lawrence Livermore Laboratory UASG 77-6, prepared for the Air Quality Maintenance Plan - Joint Technical Staff, April 12, 1977.

  This report describes two procedures for assigning hydrocarbon emissions to the three hydrocarbon reactivity utilized by LIRAQ. The first procedure is designed to convert detailed emissions by source type as provided by Trijonis, et al, into LIRAQ reactivity classes. The second is designated for use with the CARB adopted three hydrocarbon reactivity category system.

- J. Da Cunha, S. Cambell, V. Petrites, "Generation of 1975/85 Modal Split Ratios for Input to PLUM," memorandum to Modeling and Analysis Team, ABAG/MTC Joint Planning Program, Working Paper #27-Series 3, April, 1976.

  The transportation related part of the Projected Land Use Model (PLUM) allocates employed residents from zone of work to zone of residence using both highway and transit travel time matrices. The proportion of employed residents allocated to zones of residence by each mode was done using the modal split ratio at the zone of work. This report describes the procedure used to take 1965 and calculated 1990 modal split ratios and interpolate them for 1975 and 1985.

- S. Chaitkin and H. Kollo, "Series 3 Highway Network (1965, 1975, and 1985) Inputs to PLUM," memorandum to Modeling and Analysis Team, ABAG/MTC Joint Planning Program, Working Paper #29-Series 3, August, 1976.

  This working paper describes the assumptions used by the Metropolitan Transportation Commission (MTC) to develop the 1965, 1975, and 1984 440 zone matrices of travel times for the highway mode. These matrices were used by the ABAG/MTC Joint Planning Program for PLUM validation and projections. Discussed are the following characteristics of Series III highway networks for each of the three specified years: facility assumptions, speed/service level representation, supplementary travel time estimations, final preparation for input to PLUM and comparison of the resulting travel time estimations.

- S. Chaitkin and H. Kollo, "Series 3 Transit Network (1965, 1975, and 1985) Inputs to PLUM," memorandum to Modeling and Analysis Team, ABAG/MTC Joint Planning Program, Working Paper #30-Series 3, January, 1977.

  This working paper describes the assumptions used by MTC to develop the 1965, 1975, and 1985 440 zone matrices of travel times for the transit mode. These matrices were also used by the ABAG/MTC Joint Planning Program for PLUM validation and projections.

Discussed are the following characteristics of Series III transit networks for each of the three specified years: facility assumptions, speed/service level representation, supplementary travel time estimations, final preparations for input to PLUM, and comparison of the resulting travel time estimations.

- J. Holtzclaw, "Projecting Migration in the San Francisco Bay Area," memorandum to Modeling and Analysis Team, ABAG/MTC Joint Planning Program, Working Paper #33-Series 3, August, 1976.

  This working paper reviews methodologies for analyzing and projecting net migration into regions like the Bay Area. Continuing beyond ABAG's use of California Department of Finance projections in Series I and Series II, the findings of this report were used to guide the population and labor force migration projections in Series III.

- S. Hoffman, "General Description of Series 3 Projection System," memorandum to Modeling and Analysis Team, ABAG/MTC Joint Planning Program, Working Paper #36-Series 3, October 28, 1977.

  This working paper describes the Series III projection system including: 1) the models that comprise the system and their interrelationships; 2) their data inputs and projection outputs; 3) the major assumptions that control the projections; and 4) the relationship of the projections to the Environmental Management Program (EMP).

- Association of Bay Area Governments, "Summary Report - Provisional Series 3 Projections of Population, Housing, Employment, and Land Uses in the San Francisco Bay Region," March, 1977. (Final documentation available January, 1978.)

  This report summarizes projections of population, housing, employment and land uses for the San Francisco Bay Region. Provisional Series III projections are presented for the nine county region through the year 2000. For counties and smaller areas of the region the projections are presented for the period through 1990.

- M.C. MacCracken and G.D. Sauter, Eds., "Development of an Air Pollution Model for the San Francisco Bay Area" - Final Report to The National Science Foundation, Vol. 1, Lawrence Livermore Laboratory, UCRL-51920 Vol. 1, Rev. 1, October, 1975.

- M.C. MacCracken and G.D. Sauter, Eds., "Development of an Air Pollution Model for the San Francisco Bay Area" - Vol. 2 Appendices, Lawrence Livermore Laboratory, UCRL-51920 Vol.2, October, 1975.

- M.C. MaCracken, "User's Guide to the LIRAQ Model: An Air Pollution Model for the San Francisco Bay Area," Lawrence Livermore Laboratory, UCRL-51983, December, 1975.

This User's Guide has been written to assist the potential user of the LIRAQ model to conduct numerical simulations at the Lawrence Berkeley Laboratory (LBL) Computer Center. Although the models have focused on simulation of Bay Area air quality, they have been designed so that transfer to other regions is possible.

- M.C. MacCracken, D.J. Wuebbles, J.J. Walton, W.H. Duewer, and K.E. Grant, "The Livermore Regional Air Quality Model: I. Concept and Development," Lawrence Livermore Laboratory, preprint UCRL-77475 Pt. 1, Rev. 2, August, 1977.

  This and the following series of reports present the physical and mathematical basis for the Livermore Regional Air Quality (LIRAQ) model that has been developed for use in the San Francisco Bay Region. The model considers the complex topography, changing meteorology, and detailed source emission patterns in generating surface and vertical average pollutant concentrations with grid resolutions of 1, 2, or 5 km.

- W.H. Duewer, M.D. MacCracken, and J.J. Walton, "The Livermore Regional Air Quality Model: II. Verification and Sample Application in the San Francisco Bay Area," Lawrence Livermore Laboratory, preprint UCRL-77475 Pt. 2, Rev. 2, August 1977.

  In this paper, topographic, meteorological, source emission and atmospheric pollution concentration data have been assembled for use in verifying the LIRAQ-1 and LIRAQ 2 regional air quality models in the San Francisco Bay Area. These observed data indicate that the temporal and spatial phasing for concentrations of carbon monoxide, ozone, and nitrogen oxides can be adequately represented by the models.

  Limited sensitivity studies were also conducted with the LIRAQ models. The results indicate that initial and horizontal boundary conditions as well as grid size and subgrid-scale effects, while very significant in predicting air quality on the local scale, are less important in dealing with regional concentrations of pollutants than are emissions, meteorological conditions and vertical boundary conditions.

- Metropolitan Transportation Commission, Regional Transportation Plan for the Bay Area, September 1978.

  The RTP is required by both State and Federal statute. It contains policies for the orderly development of all modes of transportation within the 9-county Bay Area. The plan contains the following sections: a discussion of major transportation issues, an action element describing responsibilities for plan implementation, and a financial element.

- Metropolitan Transportation Commission, June 1978, 1978-79 Transportation Improvement Program, June 1978.

  This document lists all federally-funded highway and transit projects for the Bay Area in the next five years.

- Caltrans District 4, A Program for Preferential Treatment for High Occupancy Vehicles in the San Francisco Bay Area, July 1975.

  This report presents a program for the orderly development of preferential treatment for high occupancy vehicles on existing freeways in the Bay Area.

## Section-M

# COSTS OF OXIDANT CONTROLS

Air pollution control costs have been estimated for three different types of sources: stationary (e.g., industry), mobile (e.g., automobiles, trucks) and transportation (i.e., from vehicle miles of travel, traffic). Cost estimates are comprised of three components:

- capital construction costs
- operational and maintenance costs and revenue
- administrative/regulatory costs.

These costs will be expended over a period of time from 1977 to 2000 in accordance with a schedule of implementation (which varies with each recommendation).

The Bay Area Air Quality Management District has estimated the costs of the recommended stationary source control measures in each cost category. The California Air Resources Board has similarly estimated costs for motor vehicle emission controls and the Metropolitan Transportation Commission has estimated costs for transportation controls. These estimates are shown in Table 34. A breakdown of the costs for available control technology (Action 3 in Table 34) is presented in Table 35.

In order to be able to compare the costs of alternative AQMP control recommendations, a cost assessment convention has been applied whereby the cost components are discounted and the resultant present values are converted into equivalent annual costs.* This convention has been established by the Environmental Protection Agency in the "Guidelines for State and Areawide Water Quality Management Program Development" and it has been applied by ABAG to the other management plans as well.

Expenditures for air pollution control do not necessarily occur in the year that the plan is implemented. Therefore, costs that are expended at a future time are discounted at a prescribed rate of 6 3/8% to obtain a present value. Discounting is a way to account for the opportunity cost of funds invested in a project in the sense that the funds could be invested in alternative ways. The present value represents the amount of funds that is required at the present time which, if invested at 6 3/8%, would be sufficient to finance the recommended control at some specified future time of implementation.

*The resulting equivalent annual costs are reported in the Section I plan summary table (Table 28).

After discounting, the resultant present value costs are converted to a uniform schedule of payment over the period 1977-2000. This is the equivalent annual cost and is analogous to a monthly mortgage payment. All recommendation costs in the Environmental Management Plan are presented in this manner.

Discounting - The future costs of a control are discounted to the base year, 1977, according to the formula:

$$PV = \frac{TC}{(1 + R)^n}$$

where PV = present (i.e., discounted) value
TC = the undiscounted cost incurred in a given year
R = the discount rate = 6 3/8%
n = the number of years beyond 1977 when the cost is incurred (n=0 for 1977, 1 for 1978, 2 for 1979, etc.)

This formula is applied to each year in which a cost is incurred. The resultant present values are summed to obtain a total present value.

Salvage Value - At the end of the planning period (1999) structures and equipment are assumed to have a salvage value based on the remaining functional life of the structure. The remaining life is computed according to a straight line depreciation over an assumed service life. The salvage value is subtracted from last year's costs.

Equivalent Annual Cost - The total present value costs are converted (i.e., amortized) to an equivalent annual cost according to the following formula:

$$EAC = \frac{TPV \times R}{1 - \frac{1}{(1 + R)n}}$$

where EAC = the equivalent annual cost
TPV = the total present value
R = the discount rate = 6 3/8%
n = the number of years in the planning period = 23

Base Year - All cost estimates are in 1977 dollars. The Engineering News Record for Construction Costs (ENRCC) index was applied in cases where current estimates were not available (see Table 36).

Schedule for Implementation - Cost estimates (i.e., capital, operational/maintenance, administration/regulatory) were provided by the respective agencies with jurisdiction over the source type. An approximate time schedule for cost expenditures was subsequently developed for each control recommendation. This schedule (as shown in Table 34). formed the basis for the discounting and annualizing computations.

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| ACTION | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | available control technology | | | New Source Review | | | new vehicle emission standards | | | inspection and maintenance | | | heavy duty vehicle retrofit | | |
| | C | O/M | A/R | C | O/M | A/R | C | O/M | A/R | C | O/M | A/R | C | O/M | A/R |
| 1977 | | | | | | | | | | | | | | | |
| 1978 | | | | | | | | | | | | | | | |
| 1979 | | | | Increased cost to industry for emission offset purchases. | | | | | | | | | | | $.1M |
| 1980 | | | | | | | | | | | | | | $11M | |
| 1981 | | | | | | | | | | | | | | | |
| 1982 | | | | | | | | | | | $18.6M | $2.15M | | | |
| 1983 | $167M | | | | | | | | | | " | 1.75M | | | |
| 1984 | | | | | | | | | | | " | " | | | |
| 1985 | | $17M | | | | | | | | | 19.7M | " | | 13M | |
| 1986 | | " | | | | | | | | | 20.9M | " | | | |
| 1987 | | " | | | | | | | | | " | " | | | |
| 1988 | | " | | | | | | | | | 21.7M | " | | | |
| 1989 | | " | | | | | | | | | " | " | | | |
| 1990 | | " | | | | | | $11.4M | | | " | " | | | |
| 1991 | | " | | | | | | 22.2M | | | 23.1M | " | | | |
| 1992 | | " | | | | | | 32.4M | | | " | " | | | |
| 1993 | | " | | | | | | 42.0M | | | " | " | | | |
| 1994 | | " | | | | | | 51.0M | | | 24.5M | | | | |
| 1995 | | " | | | | | | 59.4M | | | " | " | | | |
| 1996 | | " | | | | | | 67.2M | | | " | " | | | |
| 1997 | 91M | | | | | | | 91.0M | | | 26.0M | " | | | |
| 1998 | | " | | | | | | 96.8M | | | " | " | | | |
| 1999 | | 26M | | | | | | 102.1M | | | " | " | | | |
| Economic Life (Years) | 25 | | | | | | | | | | | | | | |
| Total Equivalent Annual Cost | $18,000,000 | | | | | | $24,913,000 | | | $18,287,000 | | | $1,542,000 | | |

Notes: a) M = million
b) 1977 dollar base
c) C = capital construction costs
d) O/M = annual operating/maintenance costs and revenue
e) A/R = administrative regulatory costs
f) The economic life is stated for measures where capital construction costs are incurred. It is used to compute the salvage value of capital equipment at the end of the analysis period.

TABLE 34 -- BASE AIR POLLUTION CONTROL COSTS

| ACTION | 7 preferential parking | | | 8 additional transit | | | 9 bus/carpool lanes & ramp metering on fwys | | | 10 carpool matching program | | | 11 bicycle system | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | O/M | A/R | C | O/M | A/R | C | O/M | A/R | C | O/M | A/R | C | O/M | A/R |
| 1977 | | | | | | | | | | | | | | | |
| 1978 | | | | | | | | | | | | $300,000 | | | |
| 1979 | | | | | | | | | | | | " | | | |
| 1980 | | $1M | $30,000 | $15.8M | $7.9M | | $139M | | | | | " | | | $300,000 |
| 1981 | | " | | " | $15.8M | | | | | | | " | | | $200,000 |
| 1982 | | " | | " | 23.7M | | | | | | | " | | | " |
| 1983 | | " | | " | 31.6M | | | | | | | " | | | " |
| 1984 | | " | | " | 39.5M | | | | | | | " | $10M | | " |
| 1985 | | " | | | " | | | | | | | " | | | " |
| 1986 | | " | | | " | | | | | | | " | | | " |
| 1987 | | " | | | " | | | | | | | " | | | " |
| 1988 | | " | | | " | | | | | | | " | | | " |
| 1989 | | " | | | " | | | | | | | " | | | " |
| 1990 | | " | | | " | | | | | | | " | | | " |
| 1991 | | " | | | " | | | | | | | " | | | " |
| 1992 | | " | | | " | | | | | | | " | | | " |
| 1993 | | " | | | " | | | | | | | " | | | " |
| 1994 | | " | | | " | | | | | | | " | | | " |
| 1995 | | " | | | " | | | | | | | " | | | " |
| 1996 | | " | | | " | | | | | | | " | | | " |
| 1997 | | " | | | " | | | | | | | " | | | " |
| 1998 | | " | | | " | | | | | | | " | | | " |
| 1999 | | " | | | " | | | | | | | " | | | " |
| Economic Life | | | | 20 | | | 25 | | | Life | | | | | Permanent |
| Total Equivalent Annual Cost | | $886.000 | | $31,000,000 | | | $7,438,000 | | | $300,000 | | | $438,000 | | |

TABLE 34 (Continued)

TABLE 35. Breakdown of Costs and Hydrocarbon Emission Reductions by Process Category

| BAAPCD Process Category | Emission Reduction (Tons/Day) 1985 | Emission Reduction (Tons/Day) 2000 | CONTROL COSTS[a] 1985 CAP ($ million) | CONTROL COSTS[a] 1985 O/M ($ million) | CONTROL COSTS[a] 2000 CAP ($ million) | CONTROL COSTS[a] 2000 O/M ($ million) | BACT[b] |
|---|---|---|---|---|---|---|---|
| 2 - Petroleum Refining - Other Processes[c] | 16.9 | 22.3 | $10. | $1.1 | $17.5 | $1.1 | BM & PC (valves and flanges) |
| 3 - Petroleum Refining - Upsets, Breakdowns | 2.6 | 3.5 | 1. | .1 | 1.2 | .12 | BM & PC (valves and flanges) |
| 9 - Other Chemical | 2.6 | 3.1 | 1.5 | .075 | 1.8 | .09 | incinerator, low-no solvent coatings, fume scrubbers |
| 19 - Food/Agric. Processing | 3.7 | 4.3 | 1.5 | .075 | 1.8 | .09 | incineration |
| 23 - Storage & Blending | 17.5 | 27.9 | | | | | |
| 24 - Marine Loading | 5.4 | 8.2 | | | | | |
| 25 - Bulk Plants | .8 | 13.6 | 150. | 7.5 | 250. | 12.5 | floating roof with secondary seal, vapor recovery |
| 29 - Storage Tanks - Solvent | 5.7 | 9.7 | | | | | |
| 30 - Storage Tanks - Other Organic Compounds | 3.4 | 5.8 | | | | | |
| 31 - Industrial Coating Solvent | 38. | 52. | | | | | |
| 32 - Industrial Coating - Water | .3 | .5 | 58. | 3. | 70. | 3.5 | incinerator, low-no solvent coatings, fume scrubbers |
| 33 - Com'l. & Dom. Coating - Solvent | 19. | 23. | | | | | |
| 34 - Com'l. & Dom. Coating - Water | 2.7 | 4.5 | | | | | |

Notes:

a/ 2000 costs include those of 1985; 1975 dollar base

b/ ACT = available control technology
BM & PC = better maintenance and process changes

c/ Costs for this source category are considered underestimates, due to difficulties in isolating the cost of BACT from other process and equipment changes which refineries may opt to implement simultaneously.

Table 35 (Continued)

| BAAPCD Process Category | Emission Reduction (Tons/Day) 1985 | 2000 | CONTROL COSTS[a] 1985 CAP ($ million) | O/M | 2000 CAP ($ million) | O/M | BACT[b] |
|---|---|---|---|---|---|---|---|
| 35 - Degreasers | 35. | 42. | $6. | $.6 | $8 | $.8 | absorption |
| 36 - Dry Cleaners PERC | 13. | 30. | 2 | .2 | 5 | .5 | closed system with solvent recovery |
| 38 - Rubber Fabrication | 4.7 | 5. | 1.5 | .2 | 1.8 | .2 | solvent recovery |
| 39 - Plastic Fabrication | 23. | 28. | 6 | .6 | 7 | .7 | solvent recovery |
| 40 - Printing | 3. | 21. | 2 | .2 | 5 | .5 | absorption |
| 41 - Other Organics Evaporation | 20. | 39. | 5 | .5 | 9 | .9 | absorption |
| Total | 226.8 | 329.1 | $243 | $14. | $376. | $21. | |
| 1977 dollar base | | | $209 | 17 | 462 | 26 | |

Notes: a/ 2000 costs include those of 1985; 1975 dollar base

b/ ACT = available control technology
BM & PC = better maintenance and process changes

TABLE 36

ENGINEERING NEWS RECORD
CONSTRUCTION COST INDEX
(ENRCC)[1]

| Date | San Francisco[2] | U.S.-20 Cities Average[2] |
|---|---|---|
| January 1977 | 3100[3] | 2494 |
| May 1976 | 2824 | 2328 |
| June 1975 | 2518 | 2205 |
| July 1974 | 2287 | 2041 |
| June 1973 | 2224 | 1896 |
| July 1972 | 2074 | 1726 |
| June 1971 | 1709 | 1575 |
| June 1970 | 1515 | 1369 |
| July 1969 | 1525 | 1283 |

[1]Based on 1913 U.S. average = 100

[2]Numbers are rounded to tenths

[3]An ENRCC of 3100 is being used for the Environmental Management Plans.

# Section-N

# LIRAQ EMISSIONS SENSITIVITY ANALYSIS

This section is a more detailed description of the results of the LIRAQ emissions sensitivity analysis which was described briefly in Section H.

Table 37 gives the result of holding constant the prototype meteorology, while varying the percent reductions in future year precursor emissions. Each column of the table corresponds to a different combination of percent reductions in hydrocarbon and nitric oxide emissions. The first five columns show zero for percent reductions in NO emissions, so results in these columns pertain to reductions in only hydrocarbon emissions, with the first column being simply the 1985 baseline results. The last two columns give results for simultaneous reduction in hydrocarbon and nitric oxide emissions. All results in Table 37 are for the same inventory year, 1985, and same prototype meteorology, July 26, 1973.

Table 37. LIRAQ Emission Sensitivity Analysis Results

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| % Reduction HC | 0 | 20 | 40 | 60 | 80 | 40 | 80 |
| % Reduction NO | 0 | 0 | 0 | 0 | 0 | 20 | 40 |
| Expected worst-case regionwide high hour ozone (ppm) | .19 | .14 | .08* | .07 | .06 | .11 | .06 |

* This value was rounded off from an original value of .0846 ppm.
Assumptions: 1) 1985 Baseline Emission Inventory
2) July 26, 1973 Prototype Meteorology

Figure 39 is a plot of regionwide high hours versus percent reduction of the hydrocarbon only emissions. These curves allow a more precise interpolation of percent reduction in hydrocarbon only emissions to meet the standard. Figure 39 shows the required number to be 43% on a worst case basis.

The sixth column of Table 37 shows that the regionwide high hour for a 40% hydrocarbon emissions reduction simultaneous with a 20% nitric oxide emissions reduction is 0.11 ppm of ozone. This number is 0.03 ppm greater than the regionwide high hour for 40% only emission reduction. Figures 40, 41 and 42 have been prepared to highlight this effect. Figure 40 shows the east-west traverse AA' along which map ozone* has been plotted in Figure 41. Figure 40 is the baseline map

* "map ozone" is to be distinguished from "hourly averaged" ozone. The latter has been averaged over one hour in time. Map ozone is read directly from maps like Figure 2 and is not averaged over one hour.

for 1985 emissions and July 26, 1973 meteorology at 1500 PST, the hour when the highest map ozone occurred 9.5 kilometers SSE of Livermore. The section line AA' is through this point of maximum map ozone, as is the north-south traverse BB'. The curves labeled "baseline" in Figures 41 and 42 represent ozone cross-sections through this ozone "high", along traverses AA' and BB' respectively.

Similarly, for the 1985 inventory and July 26, 1973 meteorology, the other curves in Figures 41 and 42 represent ozone cross-sections along identical traverses AA' and BB' for LIRAQ map outputs obtained when the emissions input is reduced by 20% HC, 40% HC, 60% HC, 80% HC, and 40% HC/20% NO. Curve labels correspond to the various percent reductions.

The six curves in Figures 41 and 42 clearly show the geographic variation of the various percent reductions in precursor emissions. In particular the 40% HC/20% NO curve is shown to exceed the 40% HC only curve almost everywhere along the two cross-sections.

Subsequent to this initial series of sensitivity tests, an additional test consisting of no hydrocarbon emissions reduction and a 40% nitric oxide emission reduction was made. The result was a substantial increase in oxidant levels above the baseline level in upwind urban source areas, and a slight decrease from baseline levels in downwind non-urban areas. This result is highlighted in Figure 43 which shows the results of the 40% NO reduction test relative to the other sensitivity tests conducted.

Example maps from the sensitivity analysis tests are shown in Figures 44 through 48.

Implications for Control Strategies

The main implications are:

- reduction of hydrocarbon emissions alone is more effective than joint reduction of hydrocarbon and nitric oxide emissions, for the percentages examined,

- "Nitric oxide quenching" is a likely explanation for this result,

- a 43% reduction of hydrocarbon emissions will attain the standard in 1985,

- by extrapolation of this 1985 result**, a 56% reduction of hydrocarbon emissions will attain the standard in 2000.

** The calculation is to apply the 43% reduction to total 1985 organic emissions. This leaves 1985 total organic emissions at approximately 450 tons/day. If a 56% reduction is applied to total 2000 organic emissions, the same remainder is obtained, 450 tons/day.

The conclusion should not be reached that maximizing $NO_x$ emissions controls, to take advantage of NO quenching, is a viable strategy, for two reasons:

- a California standard presently exists for one hourly averaged nitrogen dioxide, which is exceeded in the region,

- the EPA is presently examining the criteria for a one to three hourly averaged nitrogen dioxide standard, in addition to the present annual average standard for nitrogen dioxide. EPA could issue such a standard in 1978.

FIGURE 39

PLOT OF ESTIMATED REGIONWIDE HIGH HOUR OZONE AS A FUNCTION OF % REDUCTIONS OF 1985 HC EMISSIONS

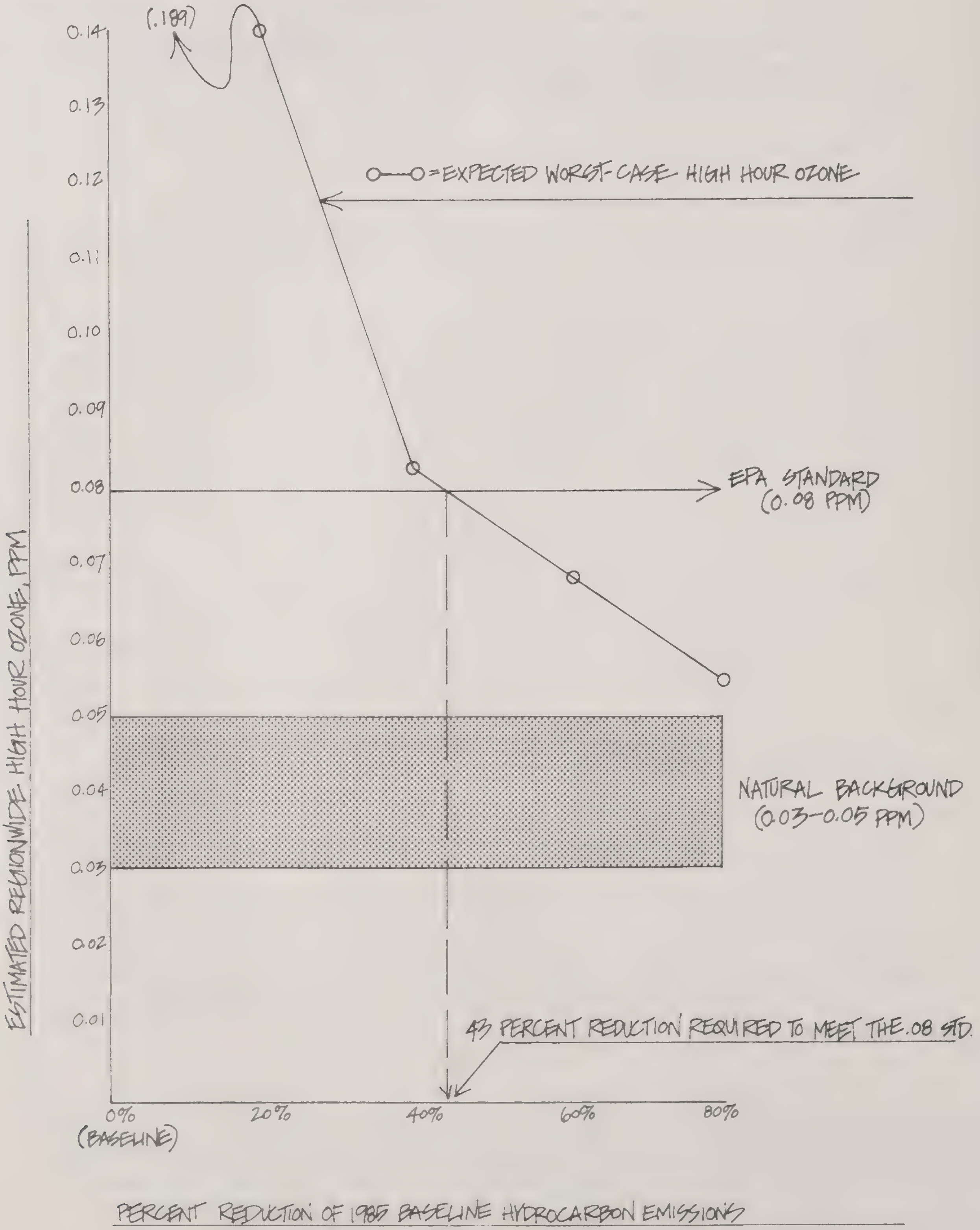


FIGURE 40 BASELINE MAP AT 1500 PST FOR 1985 EMISSIONS AND JULY 26, 1973 METEOROLOGY, SHOWING EAST-WEST SECTION LINE AA' AND NORTH-SOUTH SECTION LINE BB'

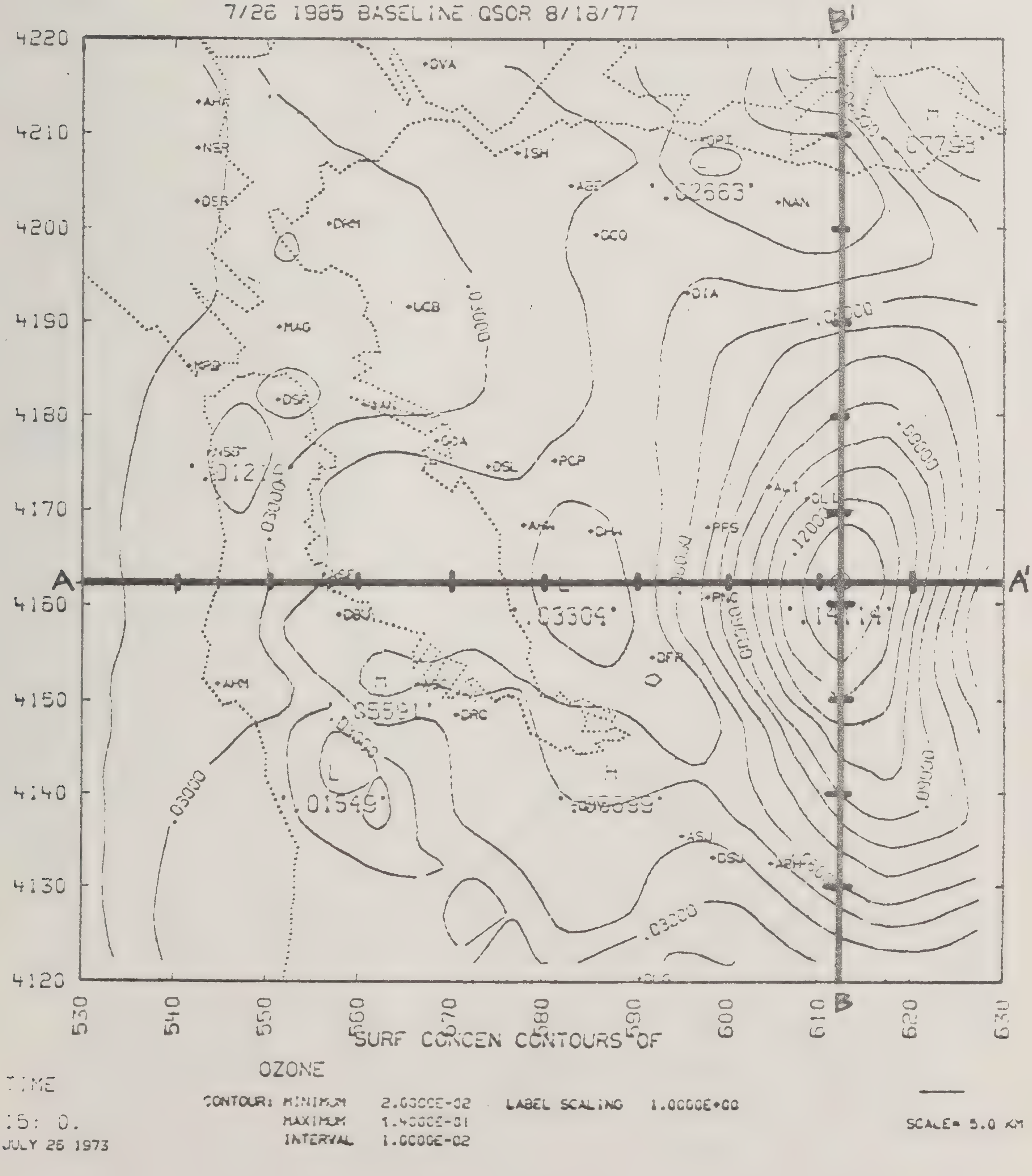


FIGURE 41 EMISSION SENSITIVITY RESULTS COMPARED BY VARIOUS PERCENT REDUCTIONS ALONG SECTION AA' OF FIGURE 40

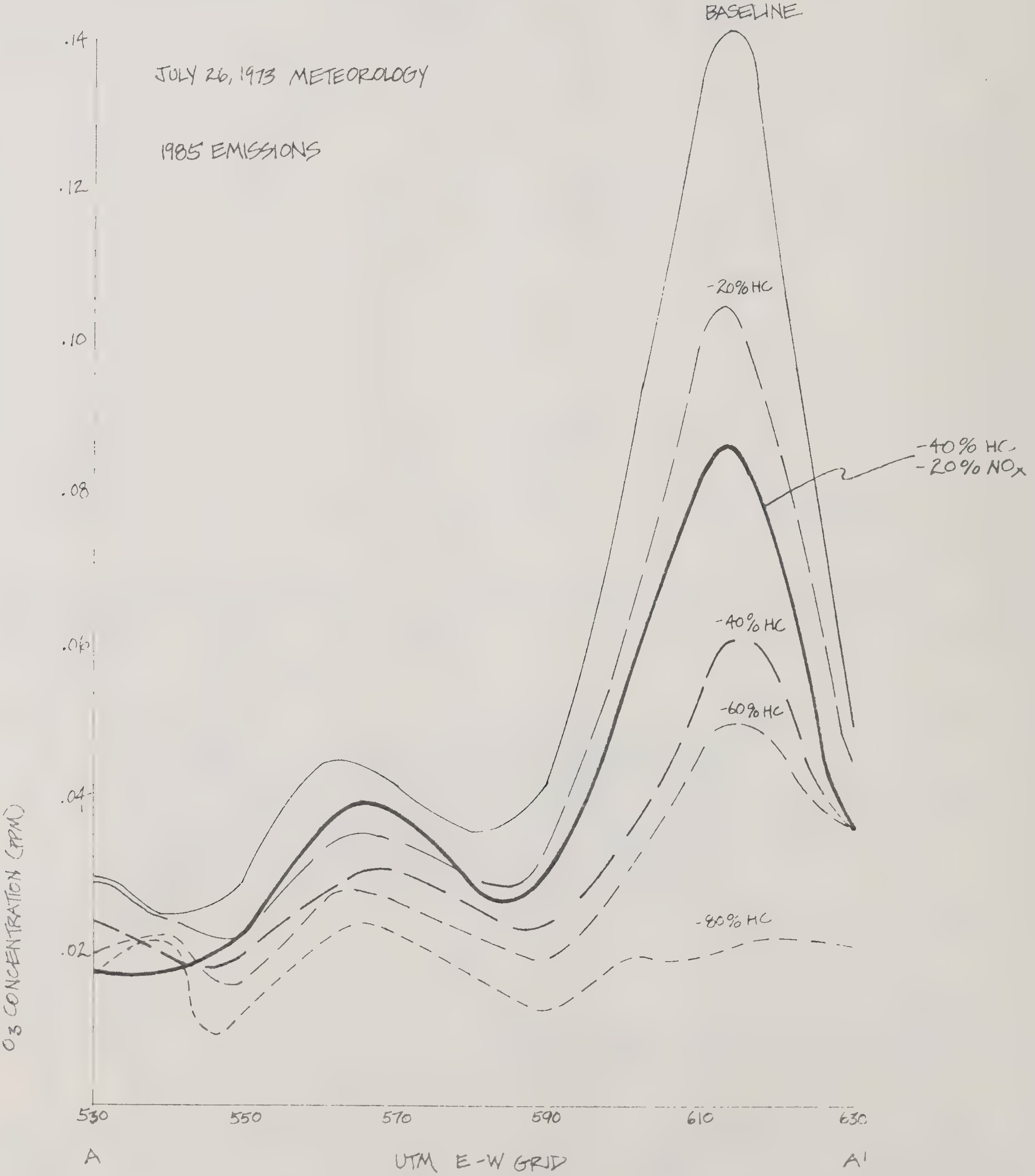


FIGURE 42 EMISSION SENSITIVITY RESULTS COMPARED BY VARIOUS PERCENT REDUCTIONS ALONG SECTION BB' OF FIGURE 40

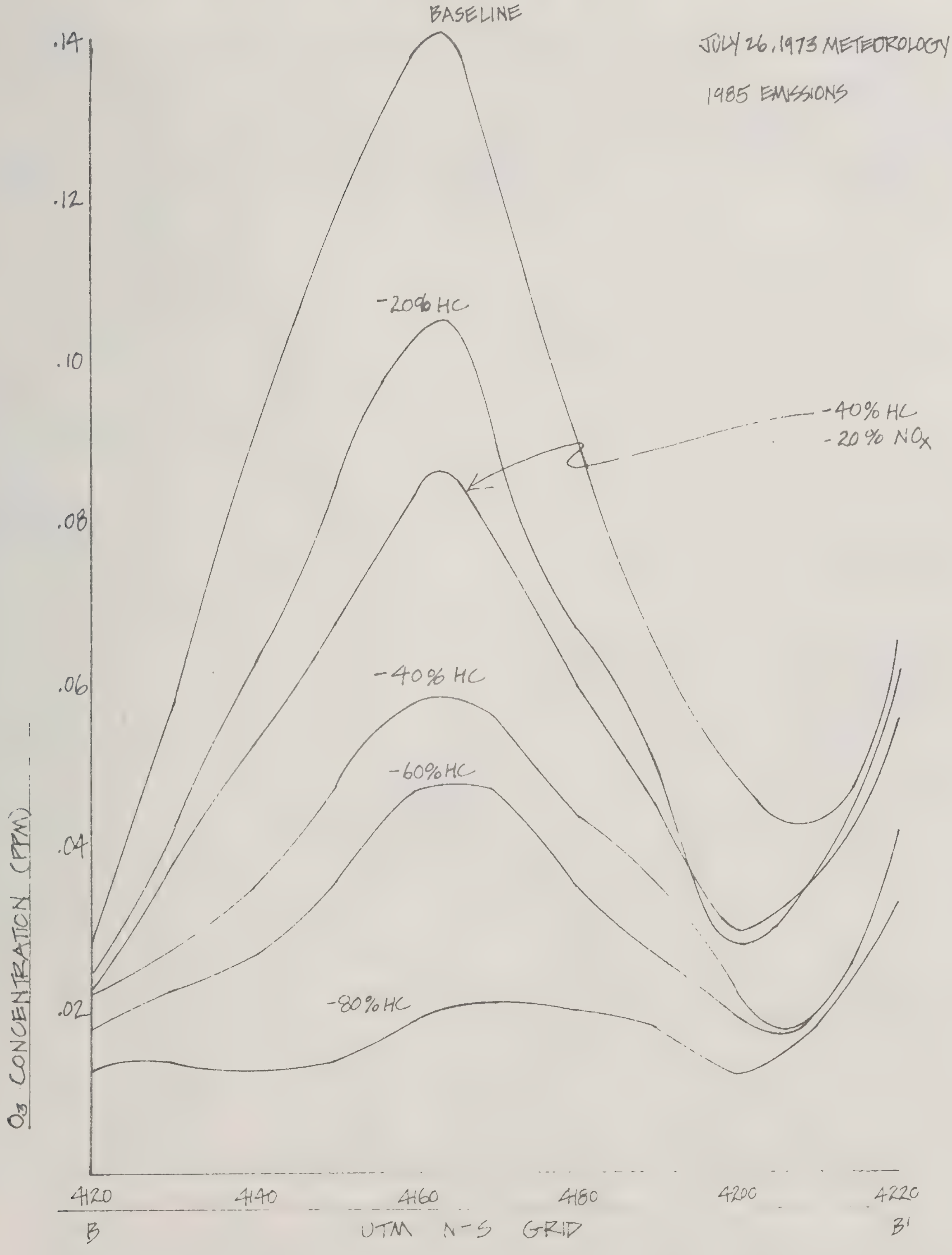


FIGURE 43- EMISSIONS SENSITIVITY RESULTS ALONG SECTION AA' OF FIGURE 40 INCLUDING THE EFFECT OF A 40% NO EMISSION REDUCTION WITH NO REDUCTIONS IN HYDROCARBON EMISSIONS.

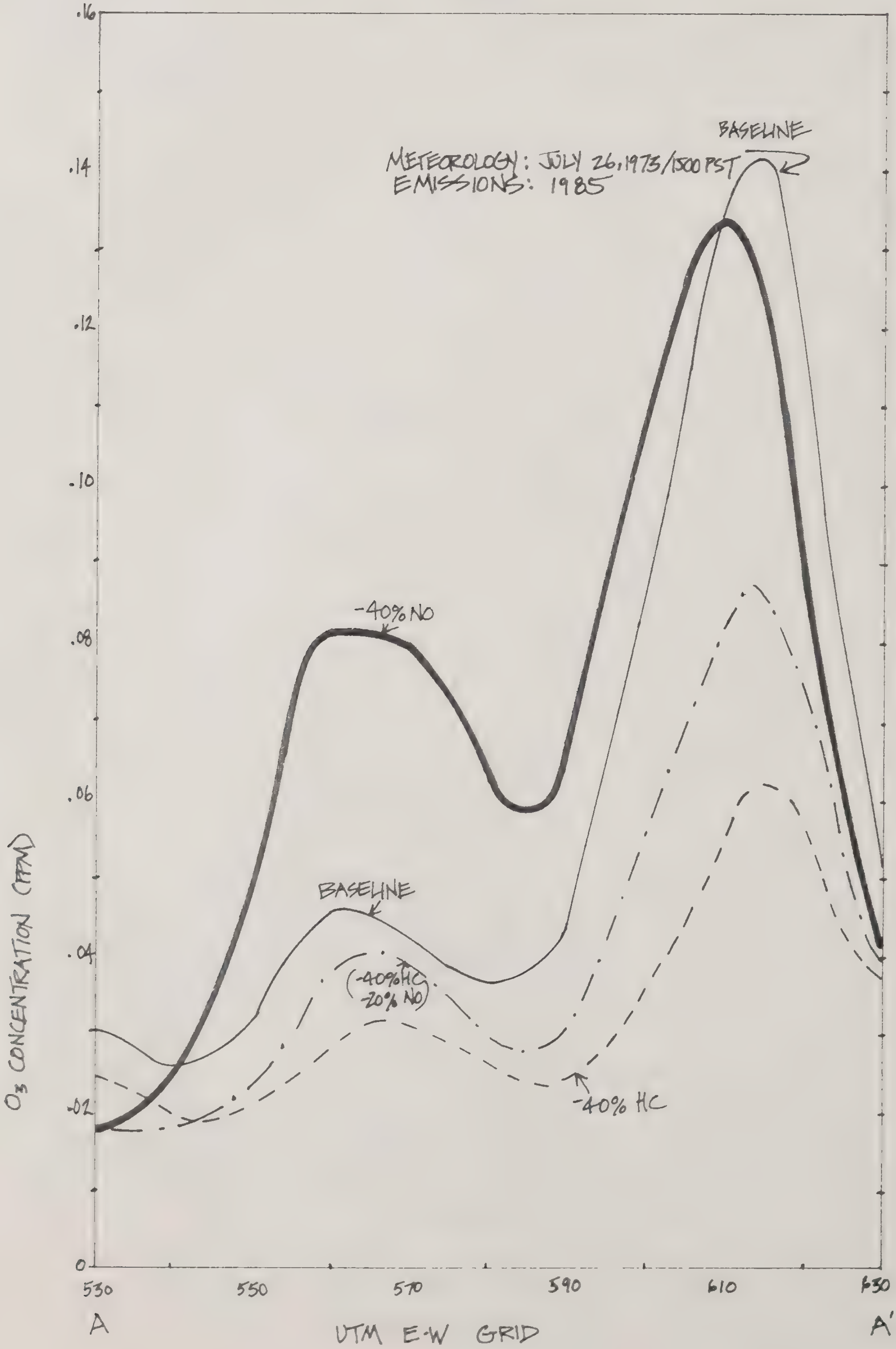
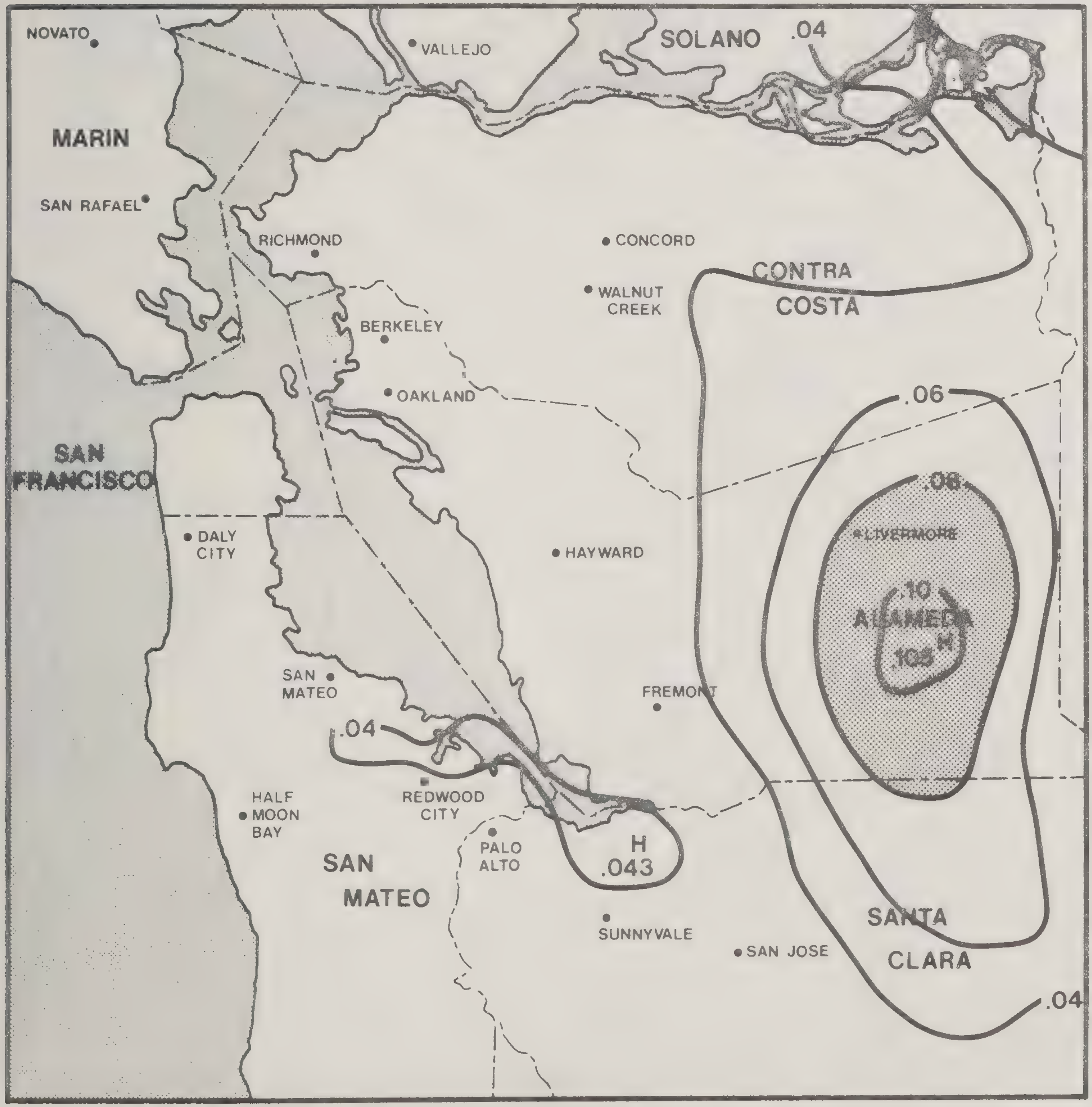


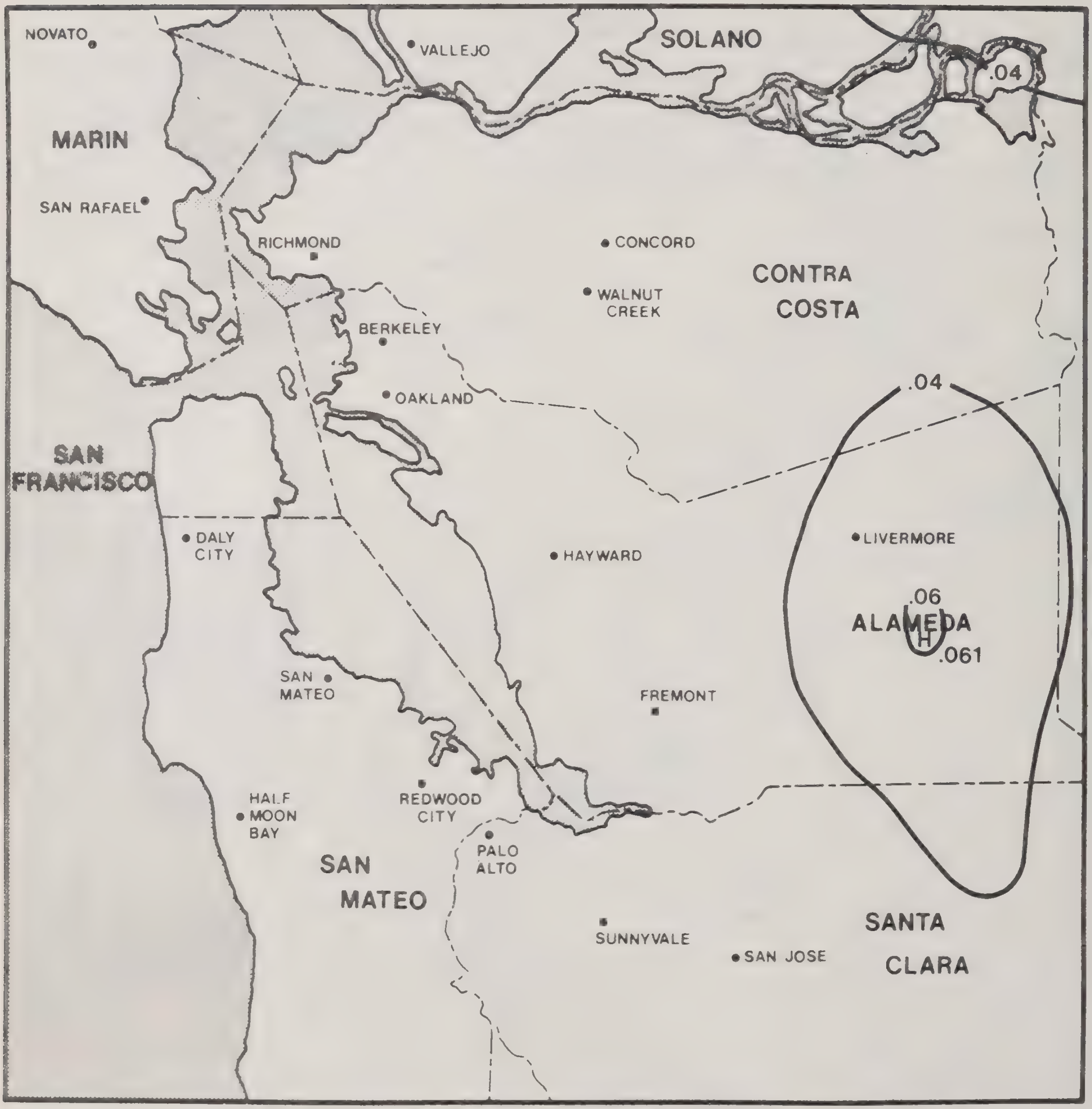
Figure 44. Example LIRAQ Results - 1985 Ozone Sensitivity Analysis
(20 Percent Hydrocarbon Reduction)




Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 1985 baseline inventory

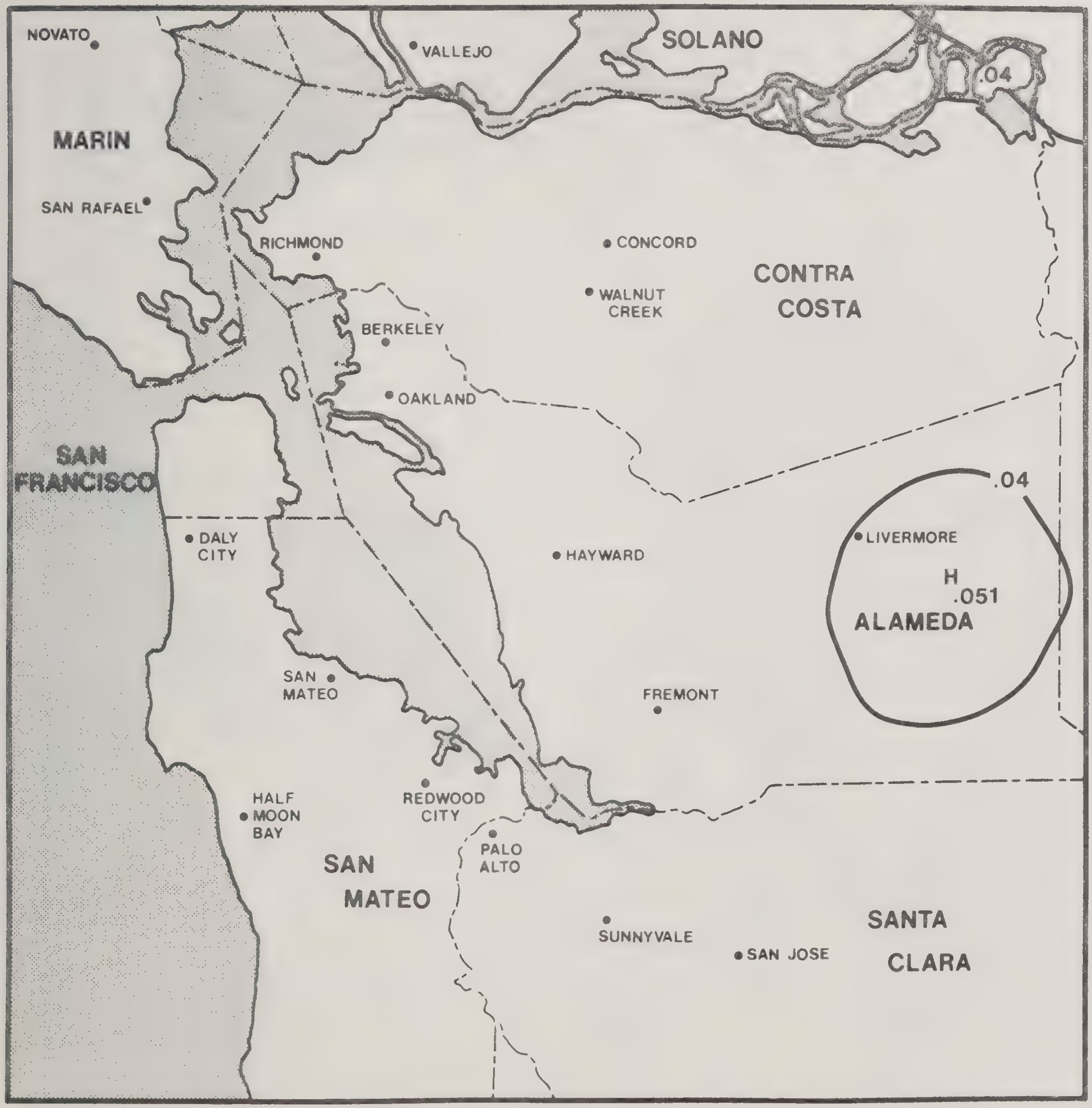
Figure 45. Example LIRAQ Results - 1985 Ozone Sensitivity Analysis

(40 Percent Hydrocarbon Reduction)



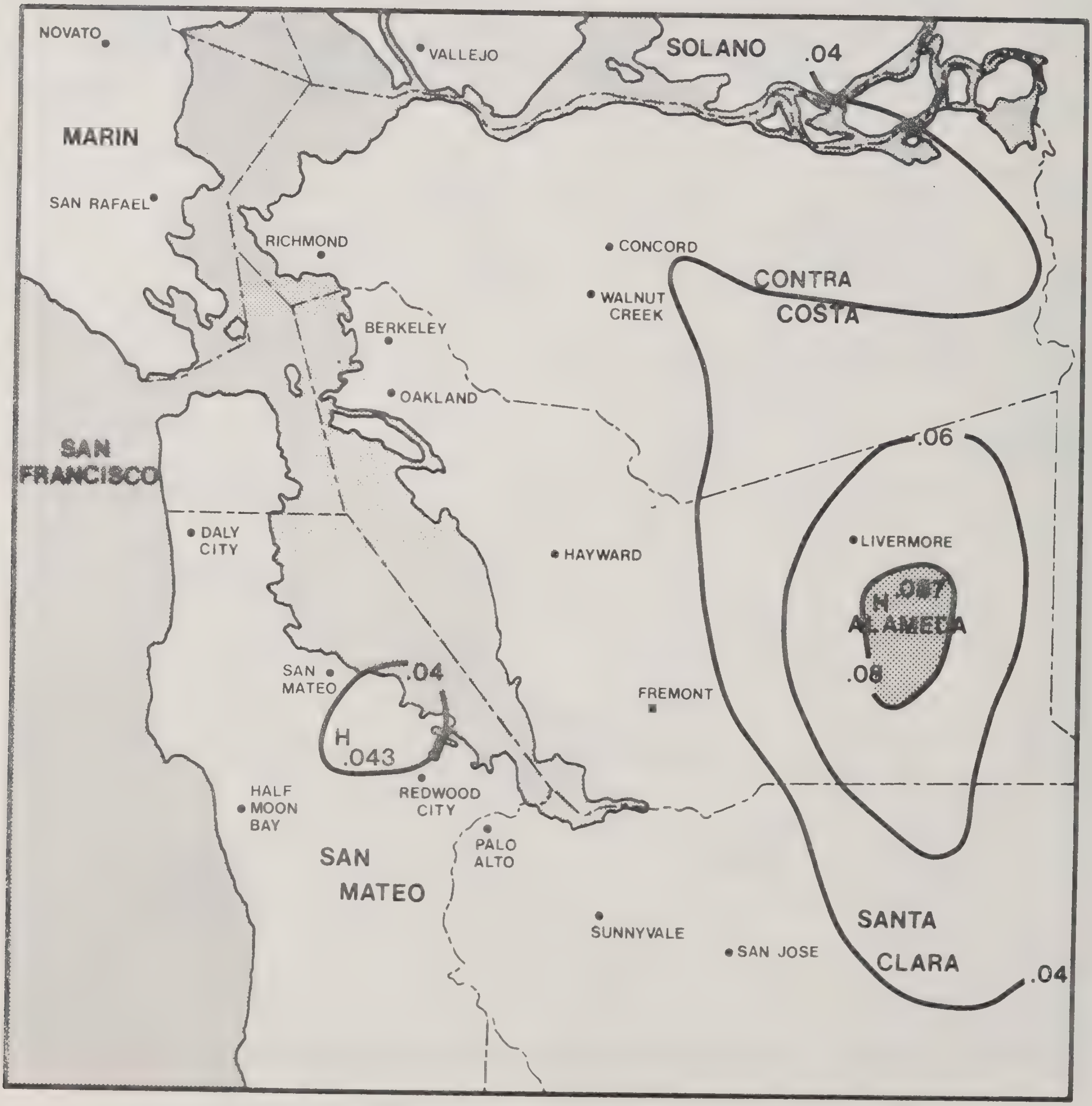

Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 1985 baseline inventory

Figure 46. Example LIRAQ Results - 1985 Ozone Sensitivity Analysis
(60 Percent Hydrocarbon Reduction)



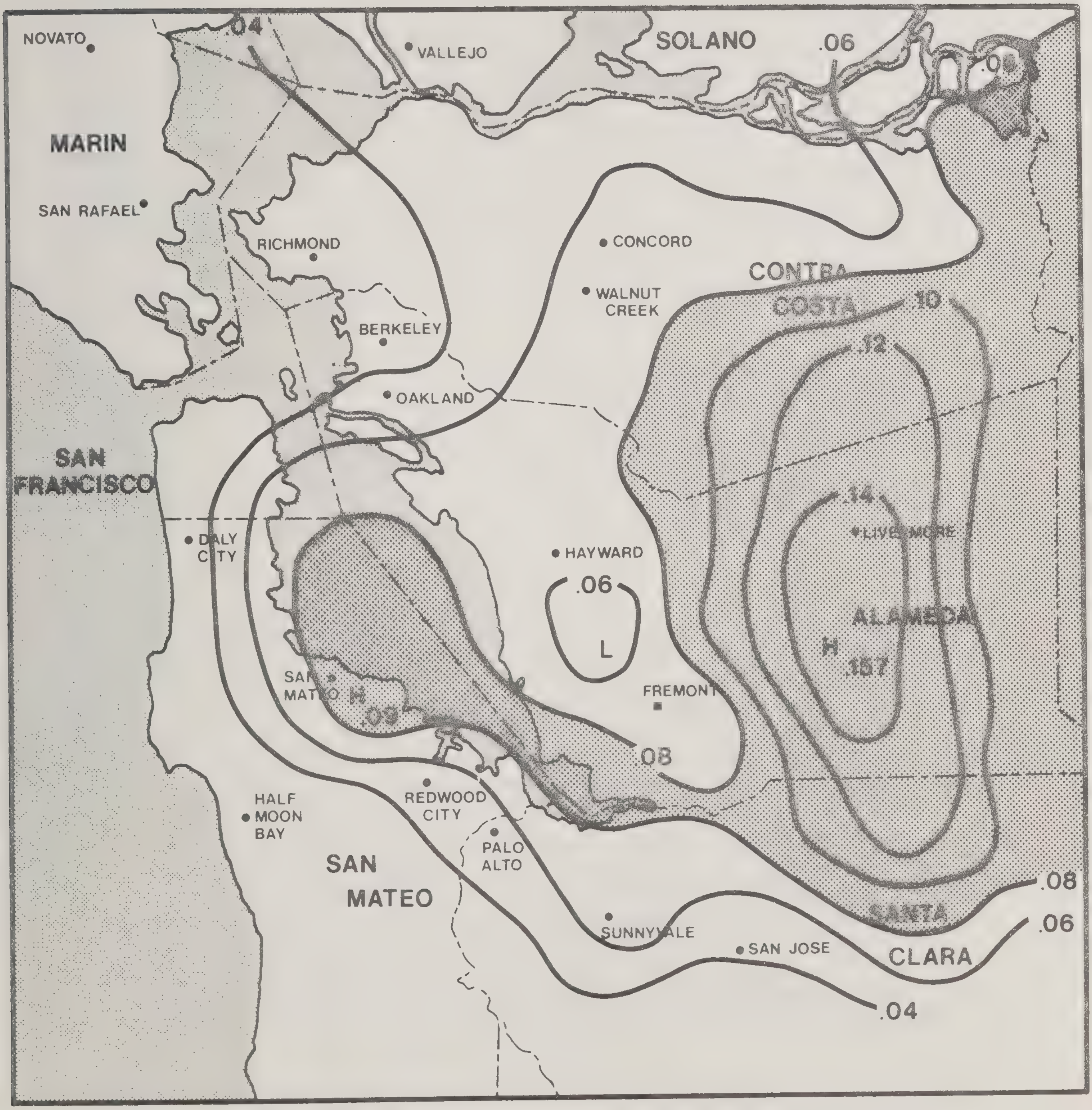

Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 1985 baseline inventory

Figure 47. Example LIRAQ Results - 1985 Ozone Sensitivity Analysis (40 Percent Hydrocarbon and 20 Percent Nitrogen Oxides Reductions)




Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 1985 baseline inventory

Figure 48. Example LIRAQ Results - 1985 Ozone Sensitivity Analysis (40 Percent Nitrogen Oxides Reduction)




Notes: 1) July 26, 1973 Prototype Meteorology (1500 Hours PST)
2) Values uncorrected for worst case conditions
3) Emission reductions taken from 1985 baseline inventory

Section-O

# CO PROBLEMS IN THE SAN FRANCISCO BAY AREA

According to data collected by the Bay Area Air Quality Management District at its continuous urban monitoring stations, the Federal one-hour CO standard has not been exceeded in the current decade.* However, the Federal 8-hour average standard of 9 ppm has been frequently exceeded in some areas. Figure 49 illustrates the number of days in 1975 which were detected by the monitoring network to exceed the 8-hour standard. The major excess area is the Santa Clara Valley, centered on San Jose and extending to Sunnyvale. There is a small secondary maximum over Vallejo, and isolated urban-center cases at San Francisco, Oakland, and San Rafael. Table 37 summarizes the excesses of the CO standards which have been recorded in recent years. The highest 8-hour average CO level recorded in recent years was 20.2 ppm, which occurred in San Jose on November 5-6, 1976.

Over 80 percent of the violations occur in November, December, and January. On a daily basis more than 90 percent of these 8-hour excesses occur between 4 p.m. and 2 a.m. The timing of the 8-hour excesses can be explained by the winter season formation of surface-based radiation inversions which correspond in time period to the evening traffic maximum. Once initiated, a sustained buildup of high CO levels occurs and remains undispersed for many hours.

## THE CO SAMPLING NETWORK

The locations of continuous CO sampling stations in the San Francisco Bay Area are also illustrated in Figure 49. There are 16 stations within the region where CO is monitored, and the sites have generally been selected to monitor representative community exposure levels for multiple pollutants (i.e., what was previously referred to as the urban background concentration). Relative to CO monitoring networks in other major metropolitan areas, the Bay Area network is among the most extensive. However, considering the significant localized variations in CO levels, it is difficult to determine whether the sites are "representative." For example, there is only one monitoring station in San Jose, a city of roughly 50 square miles in area, with a population of approximately a half million. A special survey was conducted in 1970-71 to compare CO levels measured at the San Jose station, which at the time was located about 1½ miles south of the downtown area of the city, with CO levels measured at other points across the city (see Reference 2). The results of the survey indicated that the station

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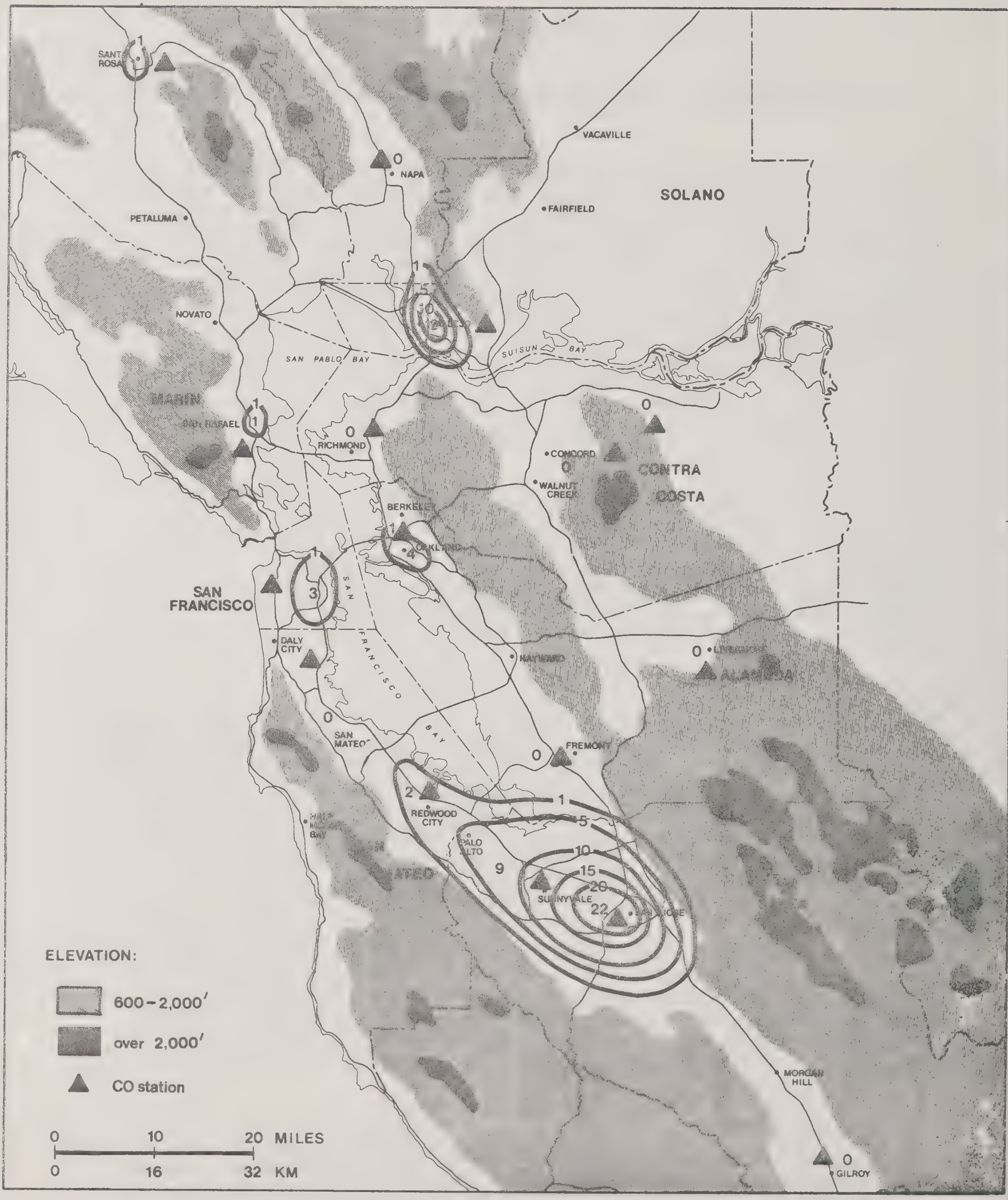
* Because of the very localized nature of CO concentrations, it is likely that the one-hour standard has been exceeded in other locations. For example, a recent BAAQMD monitoring program conducted at San Francisco International Airport recorded one-hour average CO levels as high as 86 ppm.




**1975 Annual Number of Days with Carbon Monoxide Exceeding Federal Standard (9 parts per million for 8 hours).**

Figure 49

Table 37. CARBON MONOXIDE PROBLEMS: 1975 - 1977

| | 1975 | | 1976 | | 1977 | |
|---|---|---|---|---|---|---|
| Location | Days over 8 hr. std. | High 8 hr. avg. | Days over 8 hr. std. | High 8 hr. avg. | Days over 8 hr. std. | High 8 hr. avg. |
| San Francisco | 3 | 12.9 | 4 | 11.0 | 0 | - |
| Oakland | 4 | 10.9 | 7 | 10.5 | 0 | - |
| San Jose | 18 | 15.9 | 61 | 20.2 | 32 | 14.4 |
| Sunnyvale | 9 | 10.6 | 14 | 12.8 | 1 | 10.6 |
| Vallejo | 12 | 12.6 | 40 | 18.0 | 13 | 14.2 |

underestimated the CO concentrations experienced by pedestrians on downtown First Street in San Jose and overestimated concentrations at other locations not near heavily travelled streets. In particular, eight-hour average concentrations measured adjacent to heavily travelled downtown streets were as much as three times the values recorded concurrently at the air monitoring station. Thus, it is evident that Federal ambient air quality standards can easily be exceeded at many locations without being exceeded at the monitoring stations.

The U.S. Environmental Protection Agency has prepared guidelines for siting CO monitors which recognize the wide variation in CO levels at different locations (see Reference 4). These guidelines are summarized in Table 38. Four site types are distinguished:

- Street Canyon - This site type is usually within the central business district (CBD) in an area of congested stop and go traffic, with relatively uniform and tall buildings (five stories or higher) lining both sides of the street. This type of site is further divided into peak and average sites.

- Neighborhood - This type of site is representative of those areas of uniform land use (residential and commercial, etc.) away from street canyon effects, in which a captive population (i.e., the worker, resident or invalid) is exposed. This is a longer term exposure compared to the commuter and shopper in the street canyon. This type of site is also divided into two types, peak and average.

- Corridor - This type of site is intended to bridge the gap between the street canyon site and the neighborhood site. It is intended to describe those areas in which a heavily travelled arterial or freeway impinges on a neighborhood.

- Background - This type of site is intended to represent regional or rural background CO levels.

With respect to the site classifications, the Bay Area monitoring stations may be characterized as neighborhood stations. The Vallejo station is strongly suspected to be influenced by interstate 80, and thus could be considered a corridor station. Nowhere in the Bay Area is a peak street canyon situation currently being monitored. Therefore, the representation of current CO problems provided by existing data is incomplete.

The problem with these guidelines is that with the diversity of conditions and the sheer size of the Bay Area, the Air Quality Management District

Table 38. CO MONITOR PROBE EXPOSURE CRITERIA

| Site Type | Height Above Ground | Expected Concentration Gradient with Height (1-hr. Average) | Separation of Monitor from Influencing Sources | General Remarks |
|---|---|---|---|---|
| Street Canyon | | | | Central business district high density slow moving traffic. Dense multiple story buildings lining both sides of street. > 10 m from intersection. |
| Peak Conc. | 3 ± ½ m | = .5 ppm/m | Mid-sidewalk or 2 m from side of building. On leeward side of street. | |
| Average Conc. | 3 ± ½ m | = .3 ppm/m | Mid-sidewalk or 2 m from side of building. | |
| Neighborhood | | | Setback — VPD<br>3.5 km — 100,000<br>1.5 km — 50,000<br>200 m — 10,000<br>100 m — 5,000<br>35 m — 1,000<br>25 m — any | Commercial or residential neighborhood. This separation criteria limits the effect of these streets to = 1 ppm. |
| Peak Conc. | 3 ± ½ m | 5%/m | | |
| Average Conc. | 3 ± ½ m | 5%/m | | |
| Corridor | 3 ± ½ m | < .3 ppm/m<br>> . 5%/m | Dependent on traffic volume, road configuration and set-back distance of commercial or residential activity. | Stop and go or limited access traffic > 50,000 VPD or greatest in area. |
| Background | 3 to 10 m | .2%/m | 5 to 6 km; > 3000 VPH max<br>400 m; > 100 VPD | 35 km downwind in least frequent wind direction from city, limit effects to .2 ppm. |

SOURCE: EPA, Reference 4

does not have the financial resources to fully implement them. A smaller city with a well-defined city center and uniform meteorological conditions could probably characterize its CO problems with a half-dozen CO stations. In the Bay Area, the City of San Jose alone should probably have a half-dozen stations.

TRAFFIC CONDITIONS IN THE VICINITY OF KNOWN PROBLEM AREAS

The principal sources of data that characterize CO problems in the region are the continuous monitoring stations. Since the CO levels recorded are strongly influenced by traffic conditions in the immediate vicinity of each monitor, such conditions are described for each location at which excesses of the CO standard have been recorded.

## SAN JOSE

The San Jose monitor is located in the downtown area (See Figure 50). It is in a one-story commercial building, adjacent to a small parking lot. The area around the San Jose central business district (CBD) contains a number of governmental offices and a variety of commerical establishments. Figure 51 illustrates the volumes of traffic near the San Jose monitor. The one-way couplets (1st - 4th Streets) carry significant volumes. Santa Clara Street, which is a block from the monitor, carries the heaviest traffic in the east-west direction. This street is also apparently a popular gathering spot for younger drivers on weekend evenings. The peak traffic volumes occur in the afternoon and evening hours. On Santa Clara, the peak hour has about 8% of the daily traffic, while the north-south streets generally carry about 11% of their traffic in the peak hour.

The San Jose Redevelopment Agency is anticipating several major new developments in the downtown area in the very near future, including a major hotel, several high-rise office towers and a major retail shopping center. Much of this will occur just west of San Jose State University. A number of changes in the downtown street system are anticipated. These include:

- Closure of Second Street between San Fernando and San Carlos Streets;

- Conversion of First and Second Streets to two-way traffic with one moving lane in each direction subsequent to the closure of Second Street;


Figure 50 - Location of Air Quality Monitor in San Jose

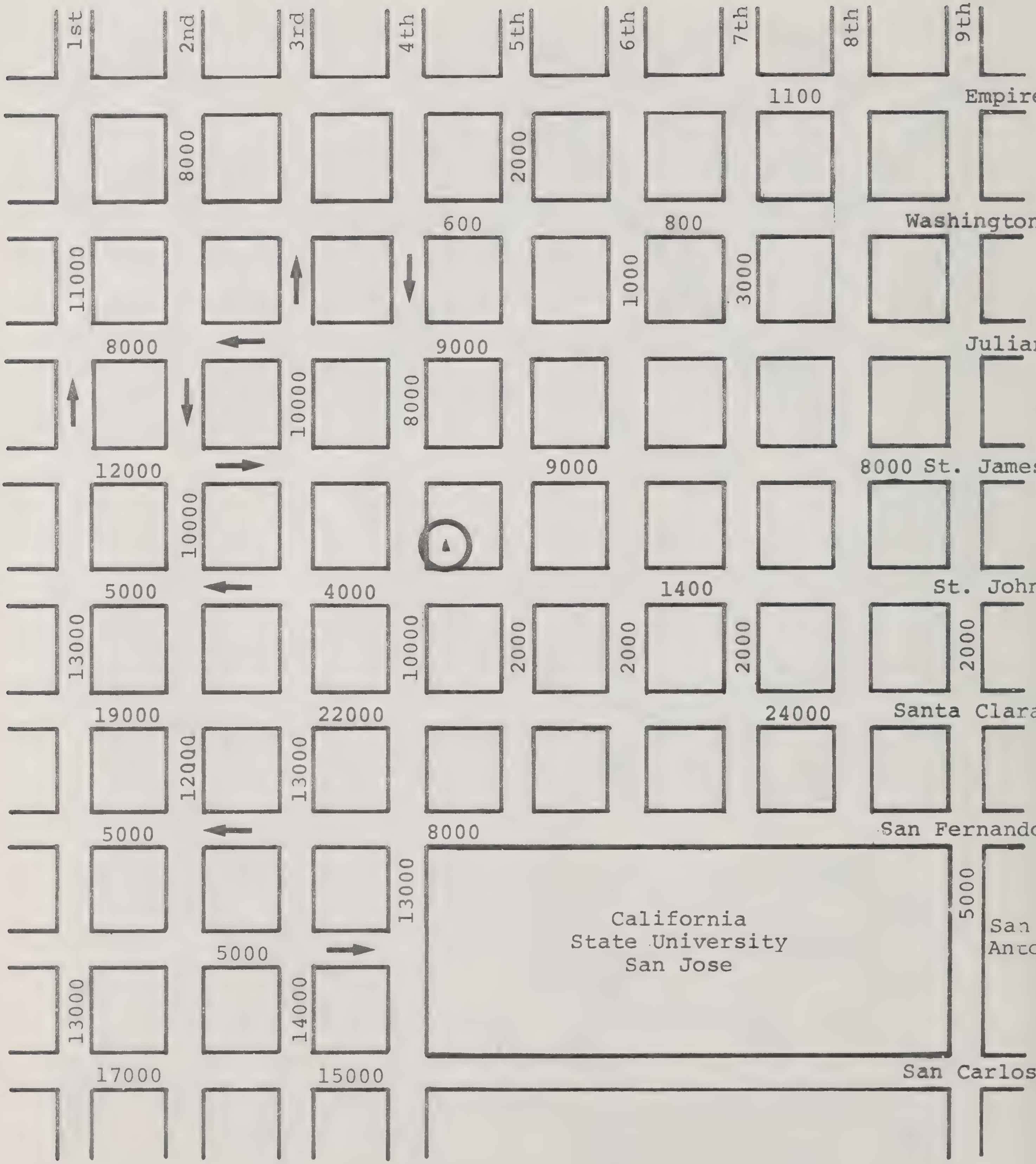



Figure 51 - SELECTED 24-HOUR TRAFFIC COUNTS IN SAN JOSE

(1973-1978)

Note: Not to scale.

- Widening and re-construction of San Fernando Street between Market and Fourth Streets to 90 feet and four moving lanes, two in each direction;

- Subsequent conversion of San Fernando Street between Fourth and Tenth Streets to two-way traffic and four moving lanes;

- Re-opening of West San Fernando Street beneath the Guadalupe Freeway viaduct to two-way traffic.

In addition to the redevelopment, a transit mobility improvement project is being developed in the San Jose CBD. The likely improvements include:

o First Street Transitway/Pedestrian Mall between St. James and San Carlos Streets (0.6 mile); centralized information booth/waiting room.

o Transit-Emphasis and Landscaping Improvements to San Fernando Street between Almaden Boulevard and Seventh Street; centralized information booth/waiting room.

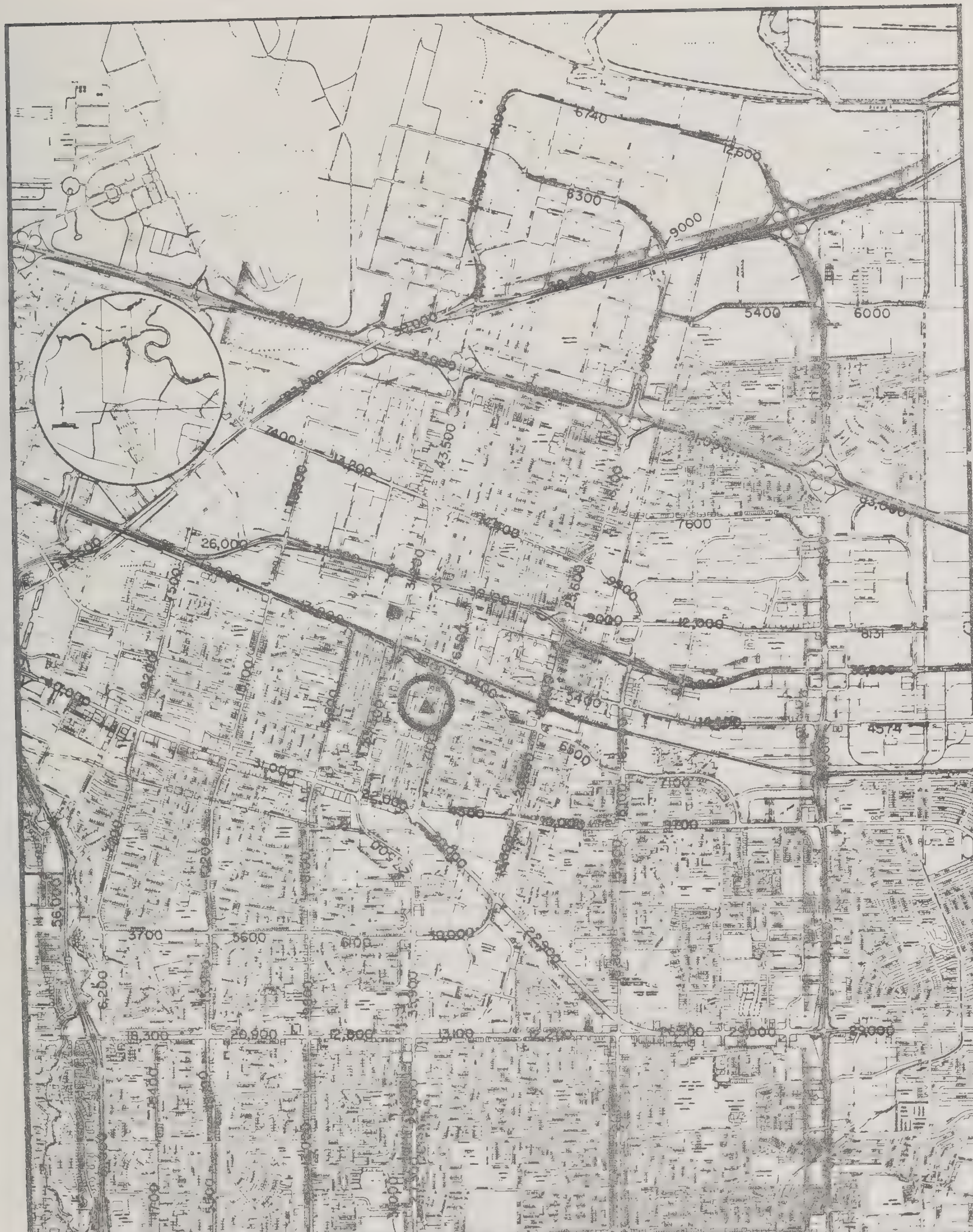
## SUNNYVALE

The Sunnyvale monitor was moved as of February 1978. This report describes the conditions around the original monitor site, since this is where the CO violations were recorded. The monitor was located in the central part of Sunnyvale on S. Murphy Avenue, a commercial street (see Figure 52). The street was two-lane and had older commercial buildings of 2-3 stories. A new shopping center is being built on this site.

Sunnyvale is typical of a number of cities in the northern Santa Clara Valley in that most of its employment centers are along Highway 101, on the north side of town, while its residents live on the south side. Thus there is heavy north-south commuting, and congested streets. One of these streets is Mathilda Avenue, 3 blocks west of the monitor. It carries more than 27,000 vehicles per day (See Figure 53), and is the major commercial street in Sunnyvale. Sunnyvale Avenue, 1 block east of the monitor, carries about 7,000 vehicles. El Camino Real is a major east-west street, located about ½ mile south of the monitor. It carries about 22,000 vehicles daily.

As mentioned earlier, a major shopping center is being built on the site where the monitor had been located. This will likely increase traffic, particularly on Mathilda Avenue. However, the city is working on an


Figure 52 - Location of Air Quality Monitor in Sunnyvale




Daily Traffic Volumes
Figure 53

CITY OF SUNNYVALE
CALIFORNIA

TRAFFIC FLOW MAP
1977

DEPARTMENT OF

DATE

innovative staggered work hours program in an attempt to relieve congestion. All firms employing 50 or more workers have been requested to participate.

## SAN FRANCISCO

The San Francisco monitor is in a commercial area just north of the Civic Center (See Figure 54). It is sited on the roof of the Air Quality Management District's building, approximately 8 stories above ground. Figure 55 presents 24 hour traffic counts on streets near the monitor and Figure 56 shows the evening peak-hour traffic. The Civic Center, just south of the monitor, is a major office center and thus significant commuter traffic passes near the monitor. Exhibition and entertainment centers are also located there. The Route 101 freeway terminates a few blocks southwest of the monitor and much of the traffic bound for the Golden Gate Bridge uses Franklin Street or Van Ness Avenue, which are on either side of the monitor. Van Ness also has extensive commercial development along the street. Geary Street, 4 blocks north of the monitor, handles a significant amount of east-west traffic.

There are no significant changes anticipated in the immediate vicinity of the monitor. Significant office development is occurring in downtown San Francisco, approximately a mile east of the monitor. The Yerba Buena Center, a major convention facility, will also be built in that area. Most of the new employees are expected to use transit, since parking is at a premium in the downtown area. However, there will be some new vehicle traffic, so some increase in volumes near the monitor can be expected.

## OAKLAND

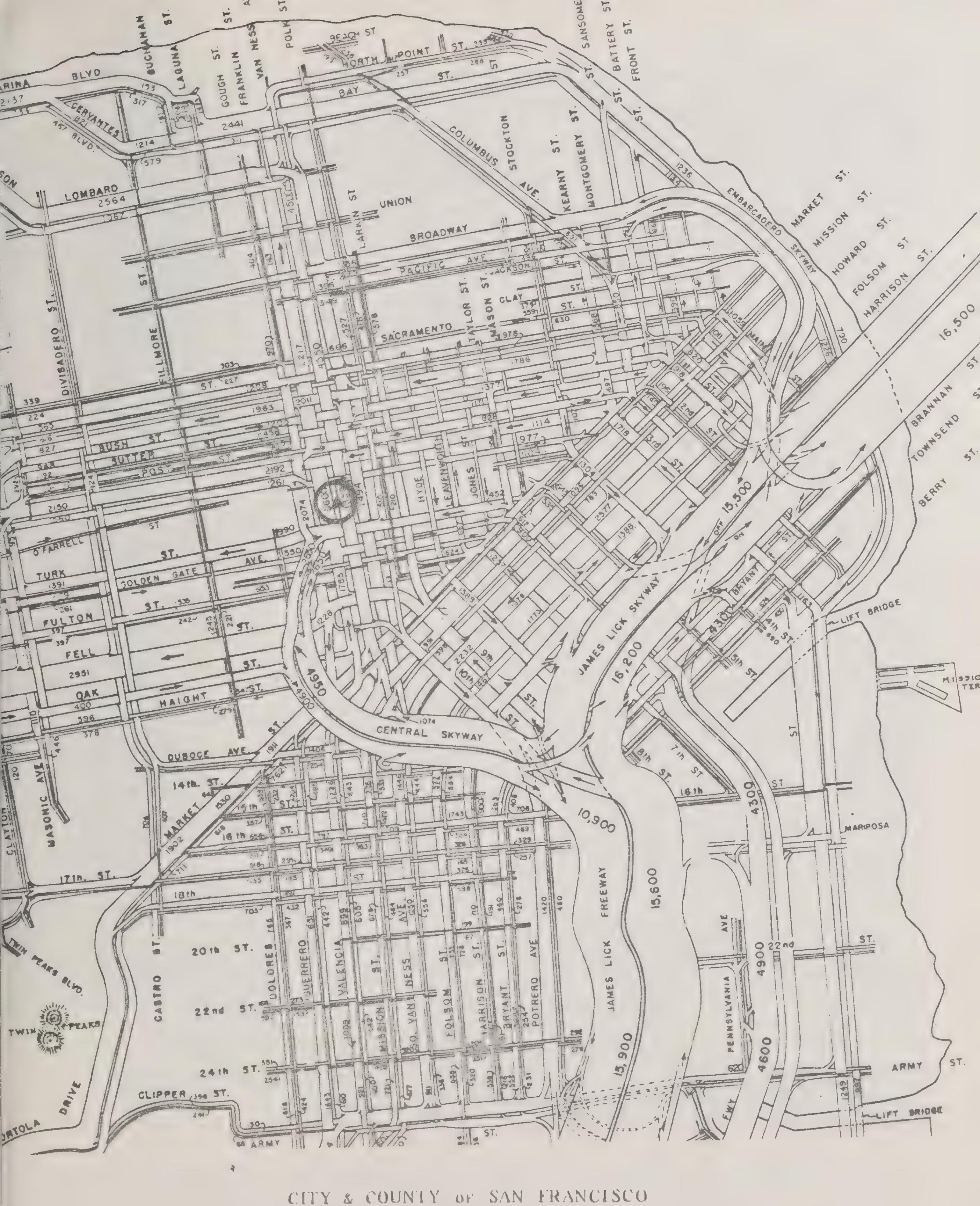
The Oakland monitor is located slightly east of the downtown area (see Figure 57) at the top of the State Building several stories above ground. It is in an area of government office building and small commercial establishments. There is fairly substantial traffic moving east on 11th Street and west on 12th Street, which connect with the underpass leading past the Municipal Auditorium and around Lake Merritt (See Figure 10). The Average Daily Traffic (ADT) on 11th Street is 7,400 vehicles with 23% occurring in the peak period of 4-6 P.M.. The ADT on 12th Street is approximately 13,000 vehicles, with 11% traveling in the 4-6 P.M. period (peak on 12th Street is in the morning).


Figure 54 - Location of Air Quality Monitor in San Francisco


CITY & COUNTY OF SAN FRANCISCO
TWENTY-FOUR HOUR TRAFFIC FLOW
ON PRINCIPAL STREETS & HIGHWAYS
1974-1976



Figure 55



CITY & COUNTY OF SAN FRANCISCO
EVENING PEAK HOUR TRAFFIC FLOW
ON PRINCIPAL STREETS & HIGHWAYS
1974 TO 1976

Figure 56

Figure 57 - Location of Air Quality Monitor in Oakland

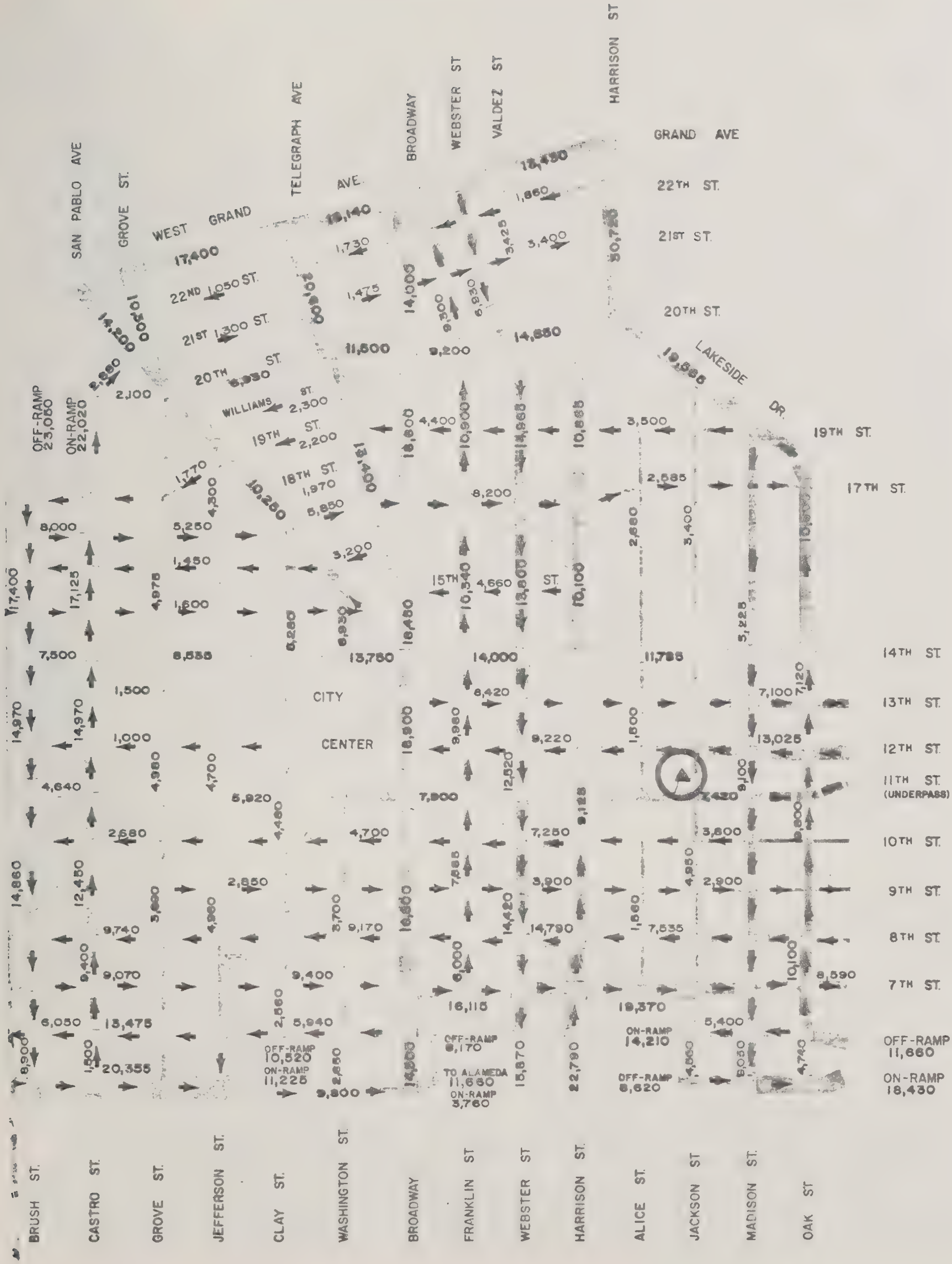



Figure 58 - City of Oakland
Traffic Flow Map
1976 ADT

The north-south streets that border the monitor are less heavily traveled, with 5,000 vehicles per day on Jackson Street and 1,500 vehicles per day on Alice Street. Fairly heavy east-west traffic also occurs on 14th Street (3 blocks away) and on 7th Street (4 blocks away). The one-way couplet of Madison and Oak Streets (1 and 2 blocks away) carries much of the north-south traffic as does Webster Street (2 blocks to the west) and the downtown streets immediately to the west of Webster. Figure 10 also shows the ADT on all the streets in the area. The Nimitz Freeway parallels 11th Street about ½ mile from the monitor location and carries an ADT of 126,000 vehicles as it crosses Jackson Street. There is an on-ramp at Jackson Street with an ADT of 14,000 vehicles and an off-ramp with an ADT of 5,000 vehicles.

Substantial commercial and residential development is planned in downtown Oakland. This will increase traffic in the area. Hong Kong U.S.A. is planned between 10th and 12th Streets and between Webster and Broadway just west of the monitor. This hotel/condominium/apartment/office complex is expected to generate considerable local traffic. The development will also result in the closing of 11th Street between Webster and Broadway. The Grove-Shafter Freeway presently ends near 18th Street in downtown Oakland. The completion of this freeway, connecting with the Nimitz Freeway and having several exits downtown, will bring more traffic to the area. The completion of the City Center commercial development in downtown Oakland will also generate increased traffic in the area. The City Center complex, which will include several large department stores and parking lots, is located ½ mile west of the monitor.

## VALLEJO

The Vallejo monitor is located slightly east of the downtown area (See Figure 59), in a commercial neighborhood. It is in a 1-story building which houses legal and medical offices as well as a restaurant. The complex is in a small triangular block, and a small parking lot is located adjacent to the building. The county office building is across the street. The primary employment center in Vallejo is the Mare Island Shipyard. Since many of the residences, particularly the newer ones, are located in the eastern and northeastern areas of the city, there is a heavy east-west flow of work traffic. Much of this traffic uses Tennessee Street, since it connects with the causeway leading to Mare Island. The Average Daily Traffic (ADT) on this route between Tuolumne Street and I-80 is about 17,000 vehicles, with about 9% of these traveling in the peak hour of 4-5 p.m. The monitor borders on two fairly busy streets. Solano Avenue is a 4-lane facility with an ADT of 9,000, with about 12% of this traveling in the 4-5 p.m. peak hour. Tuolumne Street is also

Figure 59 - Location of Air Quality Monitor in Vallejo

four-lane, has an ADT of 9,000 vehicles, with 9% of this in the evening peak hour. Capitol Avenue, the remaining street bordering on the monitor site, is a local two-lane facility. Georgia Street, a major east-west street, is about a block south of the monitor and carries about 10,500 vehicles per day, with about 8% of these in the evening peak hour. I-80 is about one-half mile east of the monitor. It has an annual ADT of 67,000 vehicles, with 7,900 during the peak hour.

Residential growth is continuing in the east and northeast sectors of Vallejo. This will probably result in heavier traffic volumes on Solano Avenue and other east-west streets. Downtown Vallejo, particularly near the waterfront, is undergoing partial redevelopment. This is likely to cause additional traffic, again primarily in an east-west direction. No significant street or highway system changes are contemplated in this area.

It is evident from the preceding descriptions that the locations where CO problems are found are not particularly unique. In fact, similar locations could undoubtedly be found in almost every city in the region. It is also evident that higher levels of carbon monoxide would probably be recorded if the sampling locations were adjacent to the busy streets and closer to street level.

# Section-P

# ALTERNATIVE SOLUTIONS TO CO PROBLEMS

This section discusses regulatory authorities for carbon monoxide controls in the Bay Area, existing control programs, and alternative control measures.

## REGULATORY AUTHORITIES FOR CONTROL IN THE BAY REGION

Motor Vehicle Emission Controls — The California Air Resources Board (ARB) is the State agency responsible for coordinating both State and Federal air pollution control programs in California. This responsibility includes regulation of pollutant emissions from motor vehicles and coordination of local programs for stationary source control.

Due to the severity of air pollution problems in California, the Federal government gives the State the option of enforcing motor vehicle emission standards which are more stringent than Federal emission standards. Thus, while the Environmental Protection Agency takes primary responsibility for motor vehicle emissions control, the ARB can and has adopted and enforced emission standards more stringent than required at the Federal level.

Transportation Controls — There are many agencies with authority to implement transportation controls in the Bay Region: the Metropolitan Transportation Commission (MTC), the California Department of Transportation (Caltrans), transit districts and cities and counties. MTC is responsible for preparing the Regional Transportation Plan, for reviewing all State and Federally funded transportation projects, and for allocating transit funds. MTC also has the authority to set tolls on all transbay bridges except the Golden Gate Bridge.

Caltrans is responsible for modifications to the State highway system (e,g,, high occupancy vehicle lanes, ramp metering), State parking facilities and the State carpool program. Individual transit districts are responsible for implementing service improvements. Federal funds for these improvements are allocated by MTC. Certain controls such as parking and traffic controls are administered by local municipalities.

Air Quality Maintenance Plan — The Air Quality Maintenance Plan (AQMP) is a plan for reducing oxidant levels in the Bay Region over the next decade. It was contained in the Environmental Management Plan adopted by ABAG's member governments in June 1978. The AQMP has been combined with recommendations covering CO and particulate matter and adopted as the 1979 Bay Area Air Quality Plan. Many of that plan's transportation measures and vehicle emissions controls designed to reduce vehicle useage and emissions, respectively, also serve to reduce CO emission levels as well. Overall coordinating responsibility for plan development and implementation and for the continuing planning process rests with the Association of Bay Area Governments. Participating agencies are the ones named above and the Bay Area Air Quality Management District.

The authority to implement most recommendations currently exists among the various State, regional, and local agencies as described previously. In a few instances, new legislation is required, e.g. for an inspection and maintenance program for light and heavy duty vehicles and the heavy duty gasoline truck retrofit program.

## EXISTING CONTROL PROGRAMS IN THE BAY AREA

Vehicle Emissions Controls – The ARB currently has regulations that control emissions from light, medium, and heavy duty gasoline powered vehicles, diesel powered trucks and buses, and motorcycles. In addition, the ARB has in effect various regulations and procedures to ensure that emission standards are met. Table 4 in Section C presents current vehicle emission standards adopted by the ARB. Recently enacted Federal statutes are also presented for comparison.

Transportation Controls – Transportation control projects currently operating in the San Francisco Bay Area are listed in Section C of this chapter. Some were required as elements of the transportation control plan, while others are the result of regional transportation planning.

## ALTERNATIVE CONTROL MEASURES

As described in the sections of this chapter covering oxidant, there are a number of alternative control measures that could act to reduce CO emissions. Since approximately 90 percent of CO emissions are from motor vehicle exhaust, the most appropriate types of controls to consider are motor vehicle emission controls and transportation controls.

CO emissions occur primarily during engine start-up (e.g., cold start and hot start emissions) and while the vehicle is in operation (hot stabilized). In addition, the emission rate varies substantially with speed, being greatest when the vehicle is idling or operating at low speeds, such as those occurring under congested, stop-and-go traffic conditions. The exhaust catalyst technology in use on post-1974 model year automobiles is most effective in reducing emissions during hot stabilized engine operation. As the number of vehicles with catalyst systems increases, the primary component of CO emissions will shift from the hot stabilized to the cold start.

Motor Vehicle Emission Controls – Further controls on light and heavy duty vehicles beyond those now in effect or scheduled for implementation consists of the following:

- More stringent new vehicle emission standards
- Exhaust retrofit for heavy duty gasoline vehicles
- Mandatory annual inspection and maintenance program
- More stringent certification of compliance procedures
- More comprehensive new motor vehicle surveillance program
- Emission standards for other mobile sources

These control alternatives are described in the plan recommendations section for oxidant (Section I).

Transportation Controls — Reducing the need to travel by motor vehicle is one way to reduce CO emissions. Another approach is to reduce congestion, expedite traffic flow, and thus raise vehicle speeds. Since CO problems are localized, it may also be possible to reduce ambient CO levels by spreading or dispersing traffic without necessarily reducing emissions. The transportation control alternatives for reducing ambient CO levels are thus formulated to satisfy one of two policy goals: to reduce vehicle use, or to improve traffic flow, as listed in Table 39.

Table 39. ALTERNATIVE TRANSPORTATION CONTROLS

Policy: Reduce Vehicle Usage

- better enforcement of parking regulations
- limit number of parking spaces
- prohibit on-street parking during peak hours
- area license
- auto-free zones
- gas rationing
- road-pricing
- increased parking costs
- provide pedestrian amenities
- provide bicycle facilities
- toll reduction for carpools
- preferential parking for carpools
- carpool-vanpool matching program
- eliminate free employee parking
- additional gasoline tax
- increased tolls
- goods movement consolidation
- additional transit service
- improved transit comfort
- bus/carpool lanes
- land use/growth management
- auto fees

Policy: Improve Traffic Flow

- encourage carpooling and transit usage
- staggered work hours
- ramp-metering
- auto-control zones
- computerized traffic control
- traffic engineering improvements
- off-street freight loading
- off-peak freight loading

# Section-Q

# FUTURE PROSPECTS AND CONTROL STRATEGY ANALYSIS FOR CARBON MONOXIDE

The technical analysis of future CO problems is complicated by four factors:

- extremely localized character of CO variations
- poor performance of available analysis tools (models)
- high sensitivity of CO emission factors to average speed estimates
- uncertainty in projected CO emission factors for motor vehicles

The uncertainty in projected CO emission factors for motor vehicles is illustrated by the fluctuation such factors have undergone over the past two years. Table 40 summarizes recent changes in CO emission factors applicable in California. The first column contains base year (1975) and projected future emission factors based on EPA's original Supplement 5 to AP-42.* The second and third columns summarize comparable emission factors from EPA's draft Supplement 8 to AP-42 (released in June, 1977), and its subsequent version, Revised Supplement 5 to AP-42 (released January 1978).** The fourth column summarizes an alternative set of CO emission factors that the California Air Resources Board (CARB) has developed. CARB is in the process of applying to EPA for approval of this alternative set of factors. The crucial aspects of this table are the remarkable differences between projected future year composite emission factors, hence the uncertainty of projecting future CO emissions.

The localized microscale character of CO problems means that proper analysis should be conducted on a localized basis. There are several air quality models from which to choose, each of varying degrees of sophistication and data requirements. Table 41 summarizes the models in common use, including one recently developed model (the Lagrangian Roadway Model), in terms of their advantages and disadvantages. Given the existing monitoring network in the Bay Area, the linear rollback model would probably substantially underestimate the magnitude of the problem and thus the degree of control necessary to achieve the CO standards. The Gaussian line source models inherently contain assumptions of steady-state, uniform meteorological conditions and emission rates, which are difficult to justify either in complex terrain or for an 8-hour computation period. EPA's HIWAY model in particular has been found to significantly overestimate CO levels under light wind and stable atmospheric conditions. The Eulerian grid models (e.g., LIRAQ)

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* EPA, "Compilation of Air Pollutant Emission Factors," AP-42, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 27711, April 1973.

** EPA, "Mobile Source Emission Factors," final document, Office of Transportation and Land Use Policy, Washington, D.C. 20460, January 1978.

TABLE 40 CARBON MONOXIDE EMISSION FACTORS (gms/mile)

| 1975 | Supp 5 (1974)[a] | Draft Supp 8 (June 1977)[a] | Rev Supp 5 (Jan.1978)[b] | CARB[b] |
|---|---|---|---|---|
| LDA | 46.7 | 52.3 | 57.8 | 58.3 |
| LDT | 54.2 | 58.0 | 60.1 | 59.6 |
| HDG | 207.2 | 272.1 | 260.8 | 186.9 |
| HDD | 28.7 | 32.2 | 32.5 | 23.7 |
| Composite | 59.2 | 69.0 | 72.6 | 67.0 |
| 1985 | | | | |
| LDA | 5.7 | 17.8 | 16.2 | 13.9 |
| LDT | 16.2 | 18.8 | 23.2 | 22.7 |
| HDG | 144.2 | 234.3 | 179.2 | 97.3 |
| HDD | 28.7 | 21.7 | 28.2 | 22.2 |
| Composite | 18.4 | 34.6 | 29.9 | 21.6 |
| 1995/2000 | | | | |
| LDA | 3.7 | 18.1 | 12.9 | 9.5 |
| LDT | 11.8 | 17.5 | 14.8 | 13.0 |
| HDG | 122.2 | 233.6 | 97.5 | 54.3 |
| HDD | 28.7 | 19.9 | 27.1 | 19.9 |
| Composite | 14.7 | 34.5 | 20.1 | 13.7 |

LDA - light duty automobiles
LDT - light duty trucks
HDG - heavy duty gasoline powered trucks
HDD - heavy duty diesel powered trucks

[a] Source: Letter from Daniel Lieberman, California Air Resources Board, to Eugene Leong, Association of Bay Area Governments, July 12, 1977. Subject: Supplement 8 Emission Factors

[b] Source: California Air Resources Board Memorandum from William C. Lockett to All AQMP Task Forces, Jack T. Kassel and George Hill, Caltrans, March 28, 1978; Subject: Motor Vehicle Emission Estimates for Planning

TABLE 41. SUMMARY OF SELECTED CO MODELING APPROACHES

| Modeling Approach | Advantages | Disadvantages |
|---|---|---|
| Linear rollback (Reference 8) | - fast and simple to apply<br>- minimal input data requirements | - relies on existing monitoring data to prescribe control levels<br>- ignores future changes in spatial and temporal patterns of emissions<br>- difficult to validate |
| Gaussian line source (References 9 and 10)<br>e.g., HIWAY CALINE-2 APRAC-II | - with certain assumptions, can address microscale peaks<br>- simple to apply | - requires microscale traffic data for input<br>- urban background CO levels difficult to obtain<br>- assumptions of steady-state and uniform meteorology are not valid for 8-hour simulations or in cases of topography common in the Bay Area<br>- some validation work required |
| Eulerian grid (Reference 11)<br>e.g., LIRAQ | - can address urban background CO levels<br>- input data previously prepared<br>- accepts non-steady state and non-uniform meteorology and emission data | - cannot address microscale peaks<br>- some validation work required |
| Lagrangian roadway (Reference 12) | - state-of-the-art microscale roadway model<br>- accepts non-steady state and non-uniform meteorological data | - validation required<br>- requires microscale traffic data for input<br>- urban background CO levels difficult to obtain<br>- more complex and expensive than Gaussian line source models |

inherently contain a substantial degree of spatial averaging of emissions and would thus be insensitive to the microscale peaks which are characteristic of ambient CO levels in the region. LIRAQ can, because of the regional coverage afforded by its grid, be used to define appropriate values for urban background CO levels across the region. Finally, the Lagrangian roadway model has been specifically developed to be applied on a microscale basis and is technically superior in its formulation to the Gaussian line source models. Thus, the most promising approach to modeling CO in the Bay Area consists of a combination of the LIRAQ model to simulate urban background levels, and the Lagrangian roadway model to simulate microscale CO peaks near roadways. When run under the same meteorogical conditions, the results of the two models may be superimposed to obtain a more complete picture of CO levels at a given location.

This approach would utilize the most sophisticated air quality analysis methods currently available and would require that concomitant traffic data at similar scales be collected for input. A crucial aspect of this traffic data is the average speed. Table 42 summarizes the variation of CO emission factors as a function of speed for light and heavy duty vehicles. The emission factors previously shown in Table 6 are multiplied by these speed correction factors. For example, the CO emission rate for light duty vehicles at 10 miles per hour is approximately double the rate shown in Table 40. This high sensitivity of CO emission factors to estimates of projected average vehicle speeds means that detailed, hourly, block-by-block traffic projections would be needed at each problem location. At the present time it is unclear whether such traffic forecasts could be made with a reasonable level of confidence.

Each of these preceding factors suggests the need for more in-depth analysis of CO problems than is possible at this time. The tasks to be undertaken as part of the continuing planning process for CO are directed toward producing the necessary in-depth analyses, and are included as part of this plan. To satisfy the minimum requirements for CO plan analysis, the current plan has been based on the linear rollback model using EPA revised Supplement 5 (AP-42) emission factors.

## Control Strategy Analysis

Table 43 summarizes the baseline CO emission inventory projection for various years. From this table, it may be seen that despite steady increases in vehicle-miles-travelled, substantial reductions in CO emissions will continue through 1987 as a result of ongoing State motor vehicle emission control programs.

The linear rollback model requires the use of the maximum 1-hour or 8-hour average Co level recorded. Since there have been no violations of the 1-hour standard recorded by Bay Area Air Quality Management District (BAAQMD) urban air monitoring stations, the maximum 8-hour average value of 20.2 ppm at San Jose was used:

$$\text{Percent CO emission reduction required} = \frac{20.2 \text{ ppm} - 9 \text{ ppm}}{20.2 \text{ ppm}} = 55.4\%$$

Before considering additional controls for carbon monoxide, the CO emission reductions due to control programs already adopted as part of the Bay Area's oxidant plan were evaluated. Tables 44 and 45 summarize the results of that evaluation. It may be seen that attainment of the CO standard (according to linear rollback) may be achieved by 1984. Lead times necessary to implement each of the control programs shown make attainment by 1982 highly unlikely. Therefore, an extension of the attainment date beyond 1982 is requested. The control programs previously adopted will, according to the linear rollback analysis, provide emission reductions sufficient to meet the CO standards. Additional data and analysis will be evaluated for subsequent plan updates, and additional controls will be proposed as needed.

TABLE 42

SPEED CORRECTION FACTORS FOR CARBON MONOXIDE (LOW ELEVATION)

| SPEED | LIGHT-DUTY AUTOS AND TRUCKS | HEAVY-DUTY GASOLINE TRUCKS | HEAVY-DUTY DIESEL TRUCKS |
|---|---|---|---|
| 5 | 4.185 | 3.070 | 1.193 |
| 6 | 3.486 | 2.616 | 1.149 |
| 7 | 2.987 | 2.293 | 1.117 |
| 8 | 2.613 | 2.050 | 1.093 |
| 9 | 2.322 | 1.861 | 1.074 |
| 10 | 2.089 | 1.710 | 1.059 |
| 11 | 1.898 | 1.586 | 1.047 |
| 12 | 1.739 | 1.483 | 1.037 |
| 13 | 1.605 | 1.396 | 1.029 |
| 14 | 1.490 | 1.321 | 1.021 |
| 15 | 1.284 | 1.227 | 1.015 |
| 16 | 1.214 | 1.171 | 1.009 |
| 17 | 1.149 | 1.119 | 1.004 |
| 18 | 1.083 | 1.070 | 1.000 |
| 19 | 1.033 | 1.025 | .939 |
| 20 | .981 | .984 | .884 |
| 21 | .933 | .944 | .834 |
| 22 | .888 | .908 | .789 |
| 23 | .847 | .874 | .748 |
| 24 | .808 | .842 | .710 |
| 25 | .772 | .813 | .675 |
| 26 | .739 | .785 | .643 |
| 27 | .708 | .759 | .613 |
| 28 | .679 | .735 | .586 |
| 29 | .652 | .713 | .560 |
| 30 | .627 | .692 | .536 |
| 31 | .604 | .673 | .514 |
| 32 | .582 | .654 | .493 |
| 33 | .561 | .638 | .473 |
| 34 | .542 | .622 | .454 |
| 35 | .525 | .607 | .437 |
| 36 | .508 | .594 | .420 |
| 37 | .493 | .581 | .404 |
| 38 | .478 | .570 | .390 |
| 39 | .465 | .559 | .376 |
| 40 | .453 | .549 | .362 |
| 41 | .441 | .540 | .349 |
| 42 | .430 | .532 | .337 |
| 43 | .420 | .524 | .326 |
| 44 | .411 | .518 | .315 |
| 45 | .403 | .512 | .304 |

SOURCE: California Department of Transportation, "Motor Vehicle Emission Factors for Estimates of Highway Impact on Air Quality," August 1976.

Table 43. BASELINE CARBON MONOXIDE EMISSION PROJECTION

| Year | Composite Emission Factor (gms/mi.)[a] | Daily vehicle miles traveled | CO Emissions (tons/day) Motor vehicles | CO Emissions (tons/day) Other sources | Total |
|---|---|---|---|---|---|
| 1975 | 72.6 | 68,608,127 | 5486 | 467 | 5953 |
| 1979 | 52.2 | 75,529,191[b] | 4342 | 498 | 4840 |
| 1980 | 47.9 | 77,259,457[b] | 4076 | 501 | 4577 |
| 1981 | 43.8 | 78,989,723[b] | 3810 | 515 | 4325 |
| 1982 | 39.9 | 80,719,989[b] | 3547 | 517 | 4064 |
| 1983 | 36.2 | 82,450,255[b] | 3287 | 533 | 3820 |
| 1984 | 32.6 | 84,180,521[b] | 3022 | 537 | 3559 |
| 1985 | 29.9 | 85,910,789 | 2829 | 538 | 3367 |
| 1986 | 27.6 | 87,978,592[b] | 2674 | 555 | 3229 |
| 1987 | 25.8 | 90,046,395[b] | 2559 | 571 | 3130 |
| 2000 | 20.1 | 116,927,835 | 2588 | 653 | 3241 |

[a] assumes 19.6 mph average speed, 75$^{o}$ F ambient temperature, 20% cold start operation, 27% hot start operation, no trailer towing, hill climbing or air conditioning corrections applied.

[b] linear interpolation

Table 44. CONTROL STRATEGY EFFECTIVENESS

| Control | Percent CO Emission Reduction from 1975 Total | | |
|---|---|---|---|
| | 1982 | 1985 | 2000 |
| Baseline (includes effects of growth and ongoing control programs) | 32% | 43% | 46% |
| Inspection/maintenance | - | 9%[a] | 12% |
| Heavy-duty gas truck retrofit | - | 11%[a] | - |
| Transportation controls | 1% | 3%[a] | 3%[b] |
| TOTAL | 33% | 66% | 61% |

[a] With an emission reduction target of 55.4% prescribed by linear rollback, only two of these three programs would be necessary to attain the CO standards. To qualify for an extension of the attainment deadline beyond 1982, however, each of these programs should be included in the plan.

[b] Transportation controls are not necessary for long term maintenance of CO standards according to the linear rollback analysis.

Table 45. EFFECTIVENESS OF TRANSPORTATION CONTROLS

| Program | Vehicle Activity Reduction | | % Emission Reduction |
|---|---|---|---|
| | Trips | Vehicle Miles Traveled | |
| Preferential Parking For Carpools | 0.1% | 0.1% | 0.1% |
| Transit Service Increase | 0.8% | 0.9% | 0.8% |
| Bus/Carpool Lanes & Ramp Metering | 0.1% | 0.1% | 0.1% |
| Ride Sharing | 0.9% | 1.2% | 0.9% |
| Bicycle Systems | 1.8% | 0.6% | 1.1% |
| Total Effectiveness | | | 3% |

## Section-R

# PLAN RECOMMENDATIONS FOR CARBON MONOXIDE CONTROL

The primary focus of the 1979 plan submission for carbon monoxide is the commitment to conduct a detailed assessment of known and suspected carbon monoxide problem areas within the region. Because CO is a localized problem, which probably occurs in many areas throughout the region, and because traffic controls may contribute to their alleviation, local cities and counties must be actively involved in the planning and implementation of carbon monoxide controls. It is anticipated that ABAG, MTC, and BAAQMD will be the focus of the technical analysis and evaluation of potential control measures--but that individual cities will share responsibility for adopting and implementing controls.

No new controls are proposed in this section. Many of the controls adopted as part of the oxidant plan would also reduce CO emissions to the degree necessary to demonstrate "reasonable further progress" toward attainment of CO standards. These controls are summarized in this section.

The plan recommendations are summarized in Table 46. For each action listed in the first column, subsequent columns of the table indicate the agencies responsible for implementing the action, the implementation schedule, costs, sources of financing, direct benefits in terms of emission reductions, and other environmental, institutional/financial, economic, and social impacts of the action.

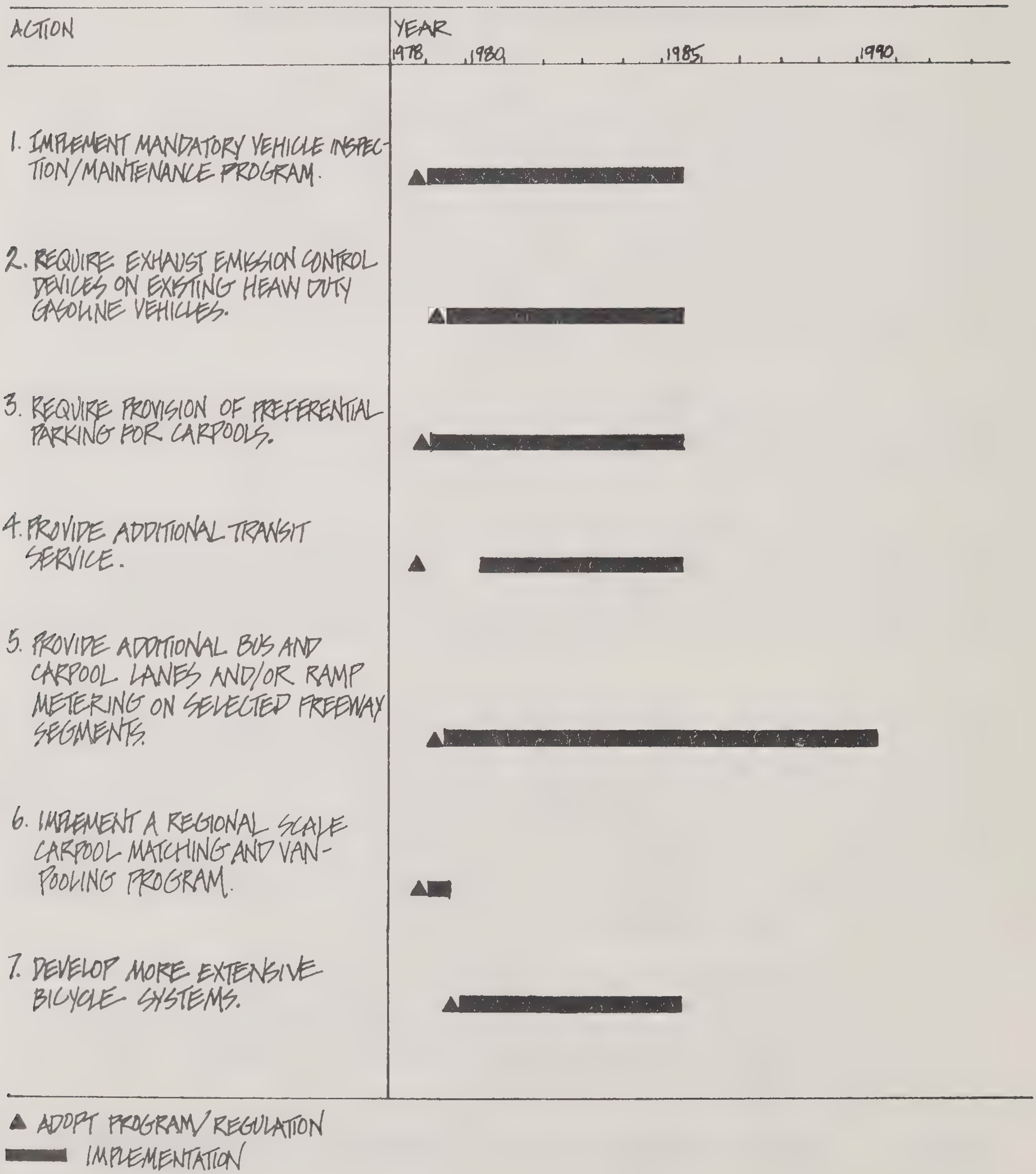
Figure 60 highlights in graphic form the schedule for implementation of each of the plan recommendations. Most of the recommendations could be adopted by appropriate agencies within two years of plan approval. However, full implementation would realistically require several years beyond the adoption phase, particularly for the most significant programs such as the inspection/maintenance program. It is therefore unlikely that the carbon monoxide standard can be met in the Bay Area by 1982. Figure 61 summarizes the projected progress toward meeting the CO standards, and indicates that attainment can be expected by 1984 if all plan recommendations are implemented.

The following narrative provides background information for the recommended actions. All actions recommended for control of CO emissions were adopted to control hydrocarbon emissions by ABAG's General Assembly in June 1978. No new actions beyond those adopted for oxidant are included in the 1979 plan to control carbon monoxide emissions.

Action 1: Implement a mandatory annual inspection and maintenance program for light and heavy duty vehicles.

While automobile emissions can be controlled by a variety of basic engine modifications and exhaust treatment devices, the state of tune of the vehicle also affects emissions significantly, regardless of what emission standards the vehicle was originally designed to meet. An incorrectly adjusted idle air/fuel ratio can double carbon monoxide emissions. Defective emission control components can cause the emissions of late model cars to equal those of uncontrolled vehicles. A program for identification and repair of vehicles with excessive emissions caused by maladjusted or defective components has the potential to significantly reduce automotive emissions.

FIGURE 60
SCHEDULE FOR IMPLEMENTATION OF THE CARBON MONOXIDE PLAN



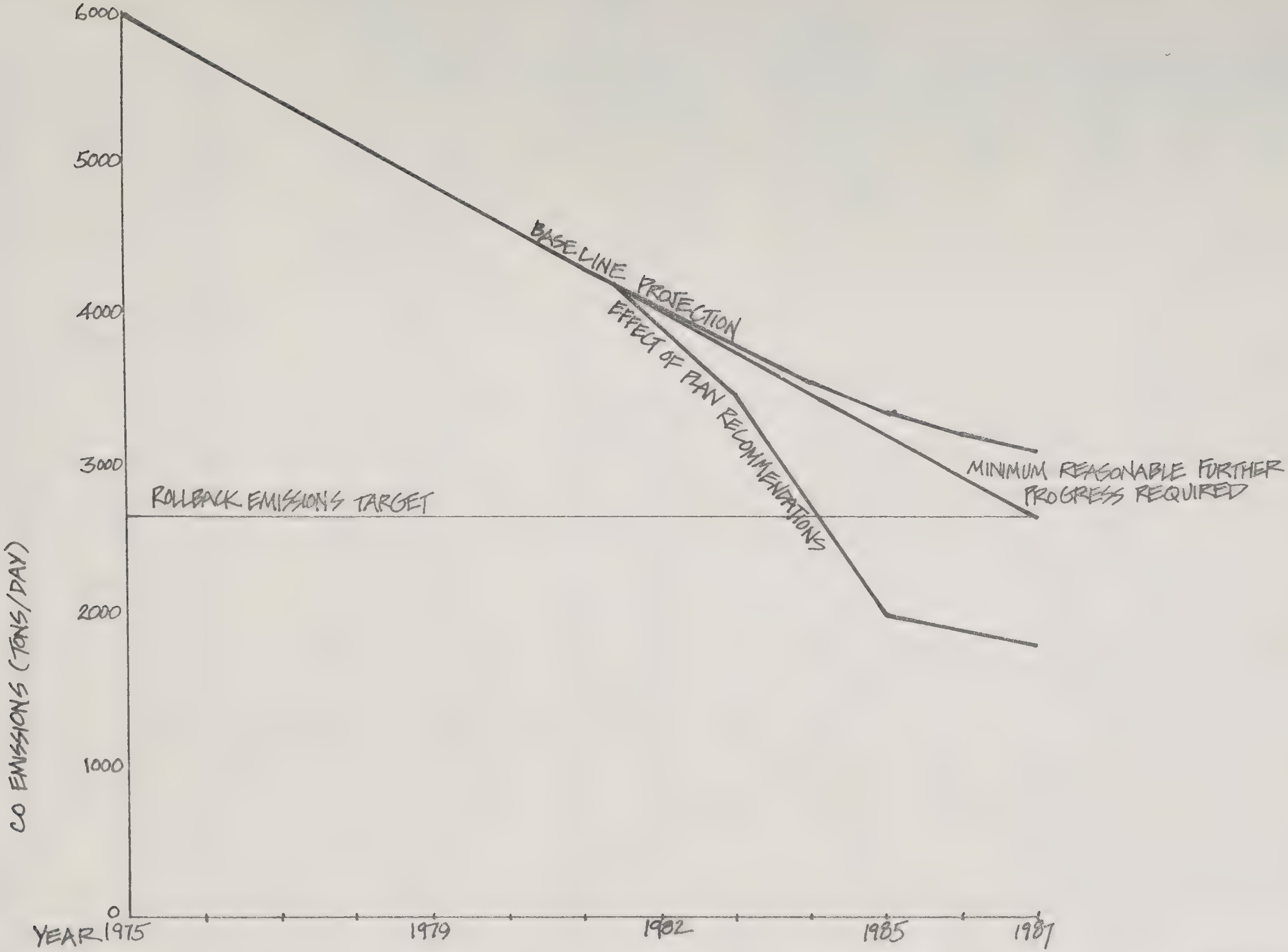



FIGURE 61

PROJECTED REASONABLE FURTHER PROGRESS TOWARD ATTAINMENT OF FEDERAL CARBON MONOXIDE STANDARDS. (BASED ON LINEAR ROLLBACK AND IMPLEMENTATION OF ALL RECOMMENDED CONTROL PROGRAMS.)

The recommendation requires inspection of all light duty automobiles starting in 1982 and the inspection of medium duty vehicles beginning in 1985. The inspections (which would take about five minutes) consists of: visual safety inspections, visual inspection of the emission control systems and exhaust smoke; automatic computer analysis of carbon monoxide and hydrocarbon exhaust gas emissions (could also include oxides of nitrogen, if loaded tests were performed), and an automatic printout of the inspection report comparing the emissions measured to acceptable limits for that particular model. If the vehicle fails the inspection it is required to be repaired by a certified mechanic and then be reinspected. If the vehicle cannot be repaired in order to meet the standard of performance for under a pre-established amount (e.g. $75) then the vehicle owner may be given a waiver for that year. This would not relieve the vehicle owner from future year inspections.

Action 2: Require exhaust emission control devices on existing heavy duty gasoline vehicles.

The regulation of emission levels from heavy duty vehicles (over 6,000 pounds gross vehicle weight) has lagged behind efforts to control light duty vehicle emissions. The slower turnover rate for heavy duty vehicles means they remain in use for a longer time than light duty vehicles. Thus, even with emissions standards for heavy duty vehicles, some control program is needed to minimize emissions from in-use vehicles before they are replace by newer and cleaner vehicles.

The recommendation requires that all heavy duty gasoline (HDG) vehicles manufactured in 1971-1982 be retrofitted with a catalytic converter by 1985. Pre-1971 models are exempt because they require leaded gasoline (leaded gasoline contaminates the catalyst). Post-1982 vehicles are assumed to be equipped with catalysts in order to meet the 1982 emissions standards already adopted by the California Air Resources Board.

Action 6 of the oxidant plan recommendations calls for an extension in the deadlines for air quality planning requirements if delays in implementing strict vehicle emission standards are granted. It is important that the Air Resources Board and the Environmental Protection Agency recognize that local agencies in California are not permitted to require direct control over motor vehicle emissions and thus, if delays in motor vehicle emission control programs occur, Federal deadlines may not be met despite local agreement that such mobile source controls should be implemented.

Transportation Controls

The following transportation actions encourage use of public transit and other high occupancy vehicle travel modes. These actions were adopted as part of the AQMP and have since been incorporated into the Regional Transportation Plan. Although these were adopted as part of an oxidant strategy, they also have a positive impact on CO emissions.

Action 3: Encourage preferential parking for carpools and vanpools.

Preferential parking could be provided to carpoolers by giving them (1) a discount on parking charges, or (2) a time saving by allocating close-in parking areas. Examples of both types are already in place in the Bay Area. The intent of this measure is to expand these programs. Details of implementation are being developed.

Action 4: Pursue a three-fold transit improvement strategy. (1) MTC, in cooperation with transit operators, will adopt service improvement objectives which can be financed by the existing commitment of resources to transit. Improved capacity, service, and ridership are contemplated. A measure of the improvement expected should be agreed to and committed to in the context of the RTP by October 1, 1978. (2) MTC will continue its efforts to identify the need for additional services (as it has, for example, in the elderly and hadicapped program and more recently in the Minority Transportation Needs Assessment Project (MTNAP) and to pursue providing additional services as they are justified. A measure of the improvement expected will continue to be developed as these special needs are examined and as the demand for transit services expands generally. (3) During the commute hours all major transit systems in the Bay Area are at capacity. Any substantial increase in ridership will be dependent upon increased Federal or State financial assistance. The amount of ridership increase is directly affected by the amount of increased State and Federal funding. Provision of additional transit capacity represents a positive transportation strategy. Thus the State and Federal governments are encouraged to provide necessary funding support for transit improvements to offset any air-quality deficiencies caused by deleting less desirable transportation control measures. Without this financial support, transit capacity cannot be significantly expanded.

Each transit operator has submitted a capital improvement program which was included in this year's Regional Transportation Improvement Program. On the basis of these improvements, each operator has adopted a ridership target. The decrease in auto travel which corresponds to this is sufficent to produce the expected emissions decrease.

Action 5: Support development of high occupancy vehicle lanes and/or ramp metering on selected freeway segments when justified on an individual project basis.

Some form of preferential treatment (special lanes on the freeways and/or ramp metering with special lanes on ramps) would be given to buses and carpools. MTC and CalTrans are studying a number of congested freeway segments to determine the feasibility of providing preferential treatment.

Action 6: Provide more ride sharing services such as jitneys and vanpools. Objectives need to be developed and monitored to gauge the desirable rate of expansion.

A non-profit corporation funded by CalTrans, the Federal Energy Administration, and MTC, has been set up to expand the RIDES carpool matching program. It has also begun a regionwide vanpool program.

Action 7: Develop more extensive and safe bicycle systems and storage facilities. Objectives need to be developed and monitored to gauge the desirable rate of expansion.

A system of bicycle facilities designed to serve short (2.5 miles or less) work, shopping, or other non-recreational trips is needed. Although these

trips do not constitute a significant portion of travel mileage, they are significant from an emissions standpoint because of the increasing predominance of trip-end emissions (cold start/hot soak) in future years.

MTC will coordinate a regional plan to facilitate this measure, but the actual implementation will be the responsibility of local jurisdictions.

Action 8: MTC is requested to consider the following action: "Complete construction of certain portions of State freeway systems in which there are now pollution-causing gaps."

The General Assembly of ABAG again requests MTC to consider this item. If agreed to by MTC, a determination of where such pollution-causing gaps occur would be necessary. Any consideration of construction to eliminate them would be analyzed and assessed as a part of the Regional Transportation Plan. Actual construction would not proceed prior to project level planning/design actions taken by Caltrans.

## IMPLEMENTATION

### Mobile Source Controls - The Role of the California Air Resources Board

Two programs are recommended for implementation by the California Air Resources Board. These control programs are:

- Implementation of an inspection and maintenance program for light and heavy duty vehicles

- Implementation of a heavy duty gasoline exhaust retrofit device for in-use heavy duty gasoline vehicles.

A vehicle inspection and maintenance program for the Bay Area would require State legislation to be implemented. This program would be carried out by the California Air Resources Board and/or the State Department of Consumer Affairs, Bureau of Automotive Repair. The Clean Air Act of 1977 requires that a specific schedule for implementation of a vehicle inspection and maintenance program be included before any time extensions beyond 1982 are allowed for meeting the CO and oxidant standards. It has been assumed that the 1977 Act requirements will be the primary moving force to getting inspection and maintenance implemented in the Bay Area. This program is important for meeting the CO and oxidant standards by 1985-87 and long term maintenance of the standards thereafter.

Implementation of a heavy duty retrofit program would require new State legislation. Such legislation would include the California Air Resources Board to be designated the appropriate implementing agency for the program. To achieve maximum effectiveness from this program, two factors are important:

- The measure would have to be implemented as soon as possible (and no later than 1985). As older vehicles are replaced the need and effectiveness of this control program diminishes.

- The measure would have to be implemented on a Statewide basis. This would prevent vehicles from being registered outside the

Table 46

# CARBON MONOXIDE

**recommendations**

| RECOMMENDATIONS | Carbon Monoxide Emission Reductions (tons/day) 1985 | 2000 | RESPONSIBLE AGENCY (or agencies) | SCHEDULE FOR ACTION A - Adoption I - Fully Implemented | TOTAL COST/YEAR OF RECOMMENDED ACTION | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|---|

# I. Mobile source controls

GENERAL POLICY: REDUCE CARBON MONOXIDE EMISSIONS FROM MOTOR VEHICLES

| RECOMMENDATIONS | 1985 | 2000 | RESPONSIBLE AGENCY (or agencies) | SCHEDULE FOR ACTION | TOTAL COST/YEAR OF RECOMMENDED ACTION | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|---|
| **Action 1** Implement Statewide inspection/maintenance program for light and heavy duty vehicles. | 635 | 714 | CARB and/or Bureau of Automotive Repair | A - 1978<br>I - 1985 | \$1,395,000[a]<br>\$16,892,000[b] | - I/M Program revenues<br>- State General Fund | New Legislation Required |
| **Action 2** Require exhaust control devices on existing heavy duty gasoline vehicles Statewide. | 555 | - | CARB | A - 1979<br>I - 1985 | \$8,000[a]<br>\$1,534,000[b] | - Private | New Legislation Required |

[a] Public agency

[b] Private

| ENVIRONMENTAL IMPACTS | INSTITUTIONAL/FINANCIAL IMPACTS | ECONOMIC IMPACTS | SOCIAL IMPACTS |
|---|---|---|---|
| Air Quality<br>o See "Direct Benefits" column.<br><br>Water Quality<br>o No impact.<br><br>Physical Resources<br>o No impact.<br><br>Energy Resources<br>o Mobile source emissions controls will produce significant energy savings through improved maintenance of engines and emission control systems.<br><br>The inspection and maintenance program and the retrofit program for heavy duty gasoline trucks could save approximately 10,000,000 gallons of gasoline per year, or about 240,000 barrels of oil per year. | Institutional<br>o The governmental structure for implementing mobile source control measures already exists in the California Air Resources Board (CARB) which presently has primary responsibility for controlling vehicular emissions in the State. However, specific institutional arrangements for implementing both the inspection/maintenance programs and the heavy duty gasoline retrofit program will be required since none of them are within the current authority of CARB.<br><br>The California Air Resources Board and/or the Bureau of Automotive Repair (BAR) would likely assume responsibility for the regulation and operation of I/M programs. Local governmental agencies involvement is not anticipated. The CARB has had experience with implementing retrofit programs in the past. It is assumed that implementation of the proposed heavy duty gasoline retrofit program would be assumed by CARB.<br><br>Inspection/maintenance (I/M) programs can be directly administered by the State, or franchised out to private contractors. Data from a pilot I/M program currently being operated in the South Coast Air Basin suggests that the operation of such programs might make disproportionate demands on the administrative resources of the State. Therefore, a private-operated/public-monitored program may be preferable for the Bay Area.<br><br>Financial<br>Direct Public Cost of Implementation<br>o See Public Costs (a) in the column headed "Total Cost/Yr of Recommended Action."<br><br>Fiscal Effect on Local Government<br>o No impact. | Production of Goods and Services<br>o The implementation of the inspection/maintenance (I/M) measures would add a new line of service for the California automotive service industry. Some services presently exist for identifying defective emission control equipment on cars. They are not, however, universally applicable to all California registered vehicles. I/M programs for light, medium, and heavy duty vehicles would offer a universally applied service program for identification and repair of vehicles with excessive emission caused by maladjusted or defective emission control equipment.<br><br>Income and Investment<br>o See Private Costs (b) in the column headed "Total Cost/Yr of Recommended Action."<br><br>Consumer Expenditures<br>o Catalytic converters are estimated to cost about $350.00 per heavy duty vehicle. (Price includes cost of the device and installation charges.) For a light and medium duty vehicle I/M programs an inspection fee of $5-6.00 per vehicle would be required. The average cost of repairs for the catalyst equipped vehicle is about $45.00. | Housing Supply<br>o No impact.<br><br>Physical Mobility<br>o Because of increased cost of private transportation, the mobility of the limited income segment of the Bay Area population may be impaired. This would be particularly true for those located in other than urban centers.<br><br>Health and Safety<br>o These control measures would substantially reduce carbon monoxide emissions from motor vehicles. Therefore, substantial health-related benefits may accrue to those segments of the population that experience the heaviest exposure to carbon monoxide concentrations while residing, working or shopping in urban centers.<br><br>Sense of Community<br>o No impact.<br><br>Equity<br>o The measures will adversely impact some groups in urban areas more severely than others--particularly those with limited income.<br><br>Urban Pattern<br>o No impact. |

## II. Transportation controls

GENERAL POLICY: REDUCE MOTOR VEHICLE EMISSIONS THROUGH TRANSPORTATION ACTIONS TO REDUCE VEHICLE USE

| RECOMMENDATIONS | Carbon Monoxide Emission Reductions (tons/day) 1985 | 2000 | RESPONSIBLE AGENCY (or agencies) | SCHEDULE FOR ACTION A - Adoption I - Fully Implemented | TOTAL COST/YEAR OF RECOMMENDED ACTION | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|---|
| **Action 3**<br>Preferential parking for carpools and vanpools. | 6 | 6 | Cities, counties, employers, MTC. | A - 1978<br>I - 1985 | $886,000[a] | - Federal Aid highway programs<br>- Local Transportation Development Act funds | - Caltrans enabling legislation<br>- Local planning and traffic control enabling legislation |
| **Action 4**<br>Pursue a three-fold transit improvement strategy.<br>(1) MTC, in cooperation with transit operators, will adopt service improvement objectives which can be financed by the existing commitment of resources to transit. Improved capacity, service, and ridership are contemplated. A measure of the improvement expected should be agreed to and committed to in the context of the RTP by October 1, 1978.<br>(2) MTC will continue its efforts to identify the need for additional services (as it has, for example, in the elderly and handicapped program and more recently in the Minority Transportation Needs Assessment Project (MTNAP) and to pursue providing additional services as they are justified. A measure of the improvement expected will continue to be developed as these special needs are examined and as the demand for transit services expands generally.<br>(3) During the commute hours all major transit systems in the Bay Area are at capacity. Any substantial increase in ridership will be dependent upon increased Federal or State financial assistance. The amount of rider- | 48 | 48 | MTC, transit districts (e.g., MUNI, AC, BART) | A - 1978<br>I - 1985 | $3[illegible] million[a] | - Federal Mass Transportation Assistance Programs<br>- Fare revenues<br>- Local Transportation Development Act Funds<br>- State Highway Trust Fund diversions | - Local Transit District Enabling Legislation<br>- Bay Area Rapid Transit District Enabling Legislation<br>- Interagency Memoranda of Understanding |

[a] Public agency

[b] Private

| ENVIRONMENTAL IMPACTS | INSTITUTIONAL/FINANCIAL IMPACTS | ECONOMIC IMPACTS | SOCIAL IMPACTS |
|---|---|---|---|
| <u>Air Quality</u><br>o See "Direct Benefits" column.<br><u>Water Quality</u><br>o No impact.<br><u>Physical Resources</u><br>o No impact.<br><u>Energy</u><br>o Gasoline savings from carpooling, the shift to transit, improved traffic flow, and the shift to bicycles.<br>o Minor increase in transit fuel consumption.<br><u>Amenities</u><br>o Cleaner air. | <u>Institutional</u><br>o Additional transit service would be provided by the present operators.<br>o Ride sharing programs would be handled by a recently established non-profit corporation.<br>o Caltrans would implement high-occupancy vehicle (HCV) lanes and carpool lots.<br>o Cities and counties would implement bibycle measures. Private employers and businesses would be encouraged to participate.<br><u>Financial</u><br>o Certain measures, notably the additional transit services, bus/carpool lanes, and bicycle systems, are costly. There is some funding available, but additional funds will be needed. MTC has suggested that the State and Federal governments provice the funding necessary to support the transit improvements. | <u>Production of Goods and Services</u><br>o New employment in the transit sector.<br><u>Consumer Expenditures</u><br>o Savings to those commuters utilizing carpools, vanpools or transit. | <u>Housing Supply</u><br>o No impact.<br><u>Physical Mobility</u><br>o Additional transit service would increase mobility of all transit users.<br>o Carpool/vanpool measures would increase travel options for most commuters.<br><u>Health and Safety</u><br>o Reduction in auto accidents with improved peak period flow.<br>o Possible increase in number, but not rate, of bicycle accidents with increased usage.<br><u>Sense of Community</u><br>o No impact.<br><u>Urban Patterns</u><br>o May encourage a more compact land use pattern, with employees living closer to transit lines and/or their jobs.<br><u>Equity</u><br>o Measures such as additional transit service will particularly benefit low income, handicapped and other persons who depend on this mode of travel. |

IMPACTS IDENTIFIED ARE FOR ACTIONS 3, 4, 5, 6, and 7.

| RECOMMENDATIONS | Carbon Monoxide Emission Reductions (tons/day) 1985 | 2000 | RESPONSIBLE AGENCY (or agencies) | SCHEDULE FOR ACTION A - Adoption I - Fully Implemented | TOTAL COST/YEAR OF RECOMMENDED ACTION | FINANCING MECHANISM | LEGAL AUTHORITY |
|---|---|---|---|---|---|---|---|
| ship increase is directly affected by the amount of increased State and Federal funding. Provision of additional transit capacity represents a positive transportation strategy. Thus the State and Federal governments are encouraged to provide necessary funding support for transit improvements to offset any air quality deficiencies caused by deleting less desirable transportation control measures. Without this financial support, transit capacity cannot be significantly expanded. | | | | | | | |
| **Action 5** Support development of high occupancy vehicle lanes and/or ramp metering on selected freeway segments when justified on an individual project basis. | 6 | 6 | Caltrans, transit districts, cities and counties. | A - 1979<br>I - 1990 | $7,438,000[a] | - Federal Aid Highway Programs<br>- State Highway Programs funds | - AB 69 (State Transportation Planning Enabling Legislation)<br>- AB 363 (Bay Region Transportation Planning Legislation)<br>- Caltrans Enabling Legislation<br>- Local Planning and Traffic Control Enabling Legislation |
| **Action 6** Provide more ride sharing services such as jitneys and vanpools. Objectives need to be developed and monitored to gauge the desirable rate of expansion. | 54 | 54 | Caltrans, employers, MTC | A- Previously adopted<br>I - 1979 | $300,000[a] | - Federal Transportation Funding | |
| **Action 7** Develop more extensive and safe bicycle systems and storage facilities. Objectives need to be developed and monitored to gauge the desirable rate of expansion. | 65 | 65 | Cities, counties, MTC, Caltrans | A - 1980<br>I - 1985 | $438,000[a] | - Federal Aid Highway Programs<br>- Local Transportation Development Act Funds | - Federal-Aid Highway Legislation<br>- Local Transportation Development Act Legislation |
| **Action 8** MTC is requested to consider the following action: "Complete construction of certain portions of State freeway systems in which there are now pollution-causing gaps." | | | MTC | 1979 | 0 | | - MTC enabling legislation |

| ENVIRONMENTAL IMPACTS | INSTITUTIONAL/FINANCIAL IMPACTS | ECONOMIC IMPACTS | SOCIAL IMPACTS |
| --- | --- | --- | --- |

Bay Area and thus exempt from the control. This would not solve the problem of vehicles registered outside the State. Since many heavy duty vehicles provide inter-state transport, the enforcement aspects of this program could pose some problems.

The heavy duty vehicle retrofit program would be implemented in two stages. The first stage would be to retrofit all 1971-76 model year vehicles by 1980. The second stage would be to require all 1977-82 heavy duty vehicles to be retrofitted by 1985. This program is primarily an attainment measure. Because of the nature of retrofit programs, only short term benefits are gained. Nonetheless, this program is an important part of the comprehensive strategy set forth in the plan for controlling CO emissions.

## Transportation Controls - The Role of the Metropolitan Transportation Commission and Others

The Metropolitan Transportation Commission is responsible for preparing the Regional Transportation Plan. The Metropolitan Transportation Commission has adopted the transportation control measures in the AQMP as part of the Regional Transportation Plan. In addition, MTC is coordinating the development of an implementation program for each control measure.

The Metropolitan Transportation Commission would assist in the development of new transit service by applying for and allocating State and Federal funds to transit operators. Actual implementation of the service improvements would be the responsibility of the individual transit districts, and would be programmed to take place over a five year period beginning in 1980.

Implementation of incentives to the use of high occupancy vehicles (e.g., carpools) would be the primary responsibility of the California Department of Transportation. Caltrans would implement the bus and carpool lanes and ramp metering measure relying primarily on federal funds, and would expand its current program of leasing lots underneath freeways and other locations to provide preferential parking for carpools. Carpool matching and data services currently provided by Caltrans will be taken over and expanded by a recently formed non-profit corporation. Finally, to encourage employers to set aside preferential parking for carpools, the Metropolitan Transportation Commission would provide planning assistance and publicity to participating employers.

Implementation of incentives to the use of non-motor vehicle forms of transportation (i.e., bicycling and walking) would primarily be the responsibility of cities and counties, with State and Federal funding assistance.

Bicycle systems are an acknowledged part of the Regional Transportation Plan. Local planners would design facilities, map routes and locations, and estimate costs, while the Metropolitan Transportation Commission would assemble the local plans into a regional plan to aid in securing State and Federal construction grants.

## THE DIRECT COSTS OF THE CO PLAN

The direct cost of each of the CO control measures were given in Table 46. They were shown in an annualized form and broken down to capital, operation and maintenance, and administrative/regulatory costs. This section briefly summarizes the costs for the two types of controls being recommended--mobile source emission controls and transportation controls.

### Mobile Source Control Costs

The annualized costs for additional mobile source controls is approximately $22 million for the Bay Area. The vehicle inspection and maintenance program would cost about $20 million anually. This cost includes a $5 per vehicle inspection fee and an average repair cost of $45 per vehicle, both paid by the behicle owner. The $5 inspection fee will cover the costs of acquiring land, constructing inspection facilities, equipment, and operation of the facilities. An additional aspect of the program would be that no vehicle owner would be required to spend more than a given amount (e.g., $75) on repairs related to emission control.

The retrofit of heavy-duty gasoline powered trucks with exhaust catalysts is estimated to cost $340 per vehicle, or a total annualized expenditure of $1.5 million for the region. This cost includes a 50,000 mile replacement waranty. The slight increase in operating cost due to the use of unleaded gasoline will be offset by a slight improvement in fuel economy.

### Transportation Control Costs

Costs associated with the transportation control recommendations are more complex than the costs for stationary and motor vehicle emission controls. In many cases a redistribution of money within the region is the net result. There are many hidden subsidies given to the use of the private automobile including a variety of public services (judicial system, coroner, fire department, on street parking, city planning, and other services typically financed from property taxes), and local ordinances which require parking to be provided by residential, commercial, and industrial developments. Because these subsidies are not structured on a "user pays" basis, there are existing inequities in the way transportation systems are financed. The current use of bridge tolls to support transit

service improvements could be viewed as a redistribution of subsidies from one transportation system to another. Increased transit services as proposed by this plan for the period to 2000 is estimated to cost $31 million annually, paid for, in substantial part, by additional Federal and State operating assistance. Additional transit service might be needed for maintenance of the standard after 1990.

The cost associated with the carpool incentive programs (preferential) parking, bus/carpool lanes on freeways with ramp metering, and an expanded carpool matching program) total about $9 million annually. The bulk of these costs are due to construction requirements for the bus/carpool lanes and ramp meters.

Finally, the cost of implementing a comprehensive system of bicycle paths and storage facilities is estimates to be approximately one-half million dollars per year. It was assumed that the paths would be striped onto existing roadways where the additional road width required would be accommodated by narrowing existing vehicle lanes.

## THE BENEFITS OF A CO PLAN

The benefits to be gained from reducing carbon monoxide emissions would be an improvement in public health. These range from reducing a potential threat to persons with heart disease to reducing interference with normal child development in pregnant women. A reduction in ambient carbon monoxide emissions could also have beneficial effects for some types of plants such as coleus, cabbage, and grapefruit. The effects of short and long-term exposure to carbon monoxide have been the subject of many studies. While conclusive evidence on causal effects cannot be documented, sufficient bodies of evidence clearly indicate the correlation between high levels of carbon monoxide and health effects. These relationships are described below.

### General Health Effects of Carbon Monoxide Exposure

With regard to physiologic effects of CO, the most important chemical characteristic of the pollutant is that, like oxygen, it is reversibly bound to the hemoglobin contained in the body's red blood cells and competes with oxygen for binding sites. Where such binding takes place, CO combines with hemoglobin to form carboxyhemoglobin. Because the affinity of hemoglobin for CO is more than 200 times that for oxygen, carbon monoxide can impair the transport of oxygen to body tissues and other vital organs in the body.

- Carbon Monoxide and Associated Carboxyhemoglobin Levels

As a result of several studies, blood carboxyhemoglobin can be estimated in the individual after he or she has been exposed to selected levels of CO for specified durations (see Table 47). These estimates apply only to persons at rest.

TABLE 47

AMBIENT CARBON MONOXIDE (CO) LEVELS AND ASSOCIATED CARBOXYHEMOGLOBIN (COHb) IN PERCENT AND AFTER 1 HR AND 8 HR EXPOSURES

| Ambient CO | | Percent COHb | |
|---|---|---|---|
| $mg/m^3$ | ppm | 1 hr (est) | 8 hr (est) |
| 115 | 100 | 3.5 | 11.3 |
| 58 | 50 | 2.5 | 7.5 |
| 35 | 30 | 1.3 | 4.1 |
| 23 | 20 | 0.8 | 2.8 |
| 12 | 10 | 0.4 | 1.4 |

Assumes normal hemoglobin, person at sea level and rest. With exercise, the 1 hour and 8 hour values would be higher. (Estimated)

Source: Benjamin G. Ferris, "Health Effects of Exposure to Low Levels of Regulated Air Pollutants-A Critical Review", Journal of the Air Pollution Control Association, p. 484, 1978, Volume 28, Number 5.

- Carbon Monoxide Effects During Exercise

  It has long been known that high blood concentrations of carbon monoxide drastically reduce the body's capacity to perform physical work. Recently, however, attention has been directed to determining the influence of lower concentrations on maximal oxygen update during such physical work. Current research has indicated that maximum capacity and therefore, maximum physical performance, is readily affected even at fairly low CO exposure concentrations.

- Chronic Carbon Monoxide Exposure

  Limited evidence suggests that chronically exposed human beings undergo adaptive changes at CO concentrations higher than those associated with usual community levels. Prolonged exposure, however, may lead to detrimental effects, including growth retardation, cardiac enlargement, and an increased rate of development of cardiovascular diseases.

## Specific Health Effects of Carbon Monoxide Exposure

In addition to the various general health effects that result from carbon monoxide exposure, the pollutant can also have some rather specific impacts on the human body. These impacts burden and impede the functions of particular body organs. In the presence of other elements or conditions that are harmful to the body, carbon monoxide could be a significant contributor to the ultimate failure of these bodily subsystems and the death of the individual. These and other specific effects are described in the following sections.

## Carbon Monoxide Effects on the Cardiovascular System

The cardiovascular system, particularly the heart, has been found to be susceptible to adverse effects from carbon monoxide at low blood carboxyhemoglobin concentration. The heart requires a continuously available supply of oxygen in order to maintain its ability to function properly. Since carbon monoxide decreases the oxygen-carrying capacity of hemoglobin, presence of the pollutant in the blood stream results in a reduction in oxygen supply available to the heart. Alterations in oxygen content are typically corrected rapidly by an appropriate increase or decrease in coronary blood flow which restores normal oxygen availability to heart tissue. The cardiovascular response to the presence of carbon monoxide then, depends on the ability of the system to dilate and increase blood flow.

Table 48 summarizes some of the studies that have shown effects at various levels of carboxyhemoglobin. It should be noted that a small amount of carboxyhemoglobin is normal and that if levels are kept below 2.5 percent no effects are apparent.

TABLE 48

LEVELS OF CARBOXYHEMOGLOBIN AND REPORTED EFFECTS

| COHb (%) | Effects |
|---|---|
| 0.4 | Normal physiologic value for non-smokers |
| 2.5-3 | Decreased exercise performance in patients with angina or with intermittent claudication |
| 4-5 | Increased symptoms in traffic policemen (headache, lassitude)<br>Increased oxygen debt in non-smokers |
| 5-10 | Changes in myocardial metabolism and possible impairment<br>Statistically significant diminution of visual perception, manual dexterity, or ability to learn |
| 10+ | Headache and impaired manual coordination<br>Changes in visual evoked response (VER) by EEG |

Source: Benjamin G. Ferris, "Health Effects of Exposure to Low Levels of Regulated Air Pollutants-A Critical Review," Journal of the Air Pollution Control Association, p. 485, 1978, Volume 28, Number 5.

## Carbon Monoxide and Heart Arterial Disease

Heart disease, characterized by abnormal thickening and hardening of arteries, is the leading cause of death in the United States. Approximately 35% of all deaths are directly attributable to this disease. The clinical characteristics of the disease are particularly pertinent for establishing a causal relationship between it and abnormal thickening and hardening of the coronary arteries. Neither its frequency nor its prevalence in the general human population are known. Very little is known about the specific factors that cause the disease. However, agents that decrease the available oxygen supply, including CO, are primary suspects as precipitating factors in heart attacks.

Environmental exposure to CO and artery-related heart disease may be related in two ways. One of these is that exposure to CO can enhance the development of thickened arteries when associated with other risk factors such as increased cholesterol levels and hypertension. The other is that, in the presence of already severely narrowed arteries, carbon monoxide may be the contributing factor to heart attack.

## Carbon Monoxide and Increased Morbidity

Several studies suggest that when people with such heart diseases as Angina Pectoris are exposed to low carbon monoxide concentrations they tend not to be able to exercise as long before developing chest pain, as those with the disease who have not been so exposed. As a result of these investigations and others, it has been suggested that a carboxyhemoglobin concentration as low as 2.5 percent has a deleterious health effect. Since all cigarette smokers and about 10 percent of the nonsmokers in the United States frequently have carboxyhemoglobin concentrations higher than 2.5 percent these studies have important implications. The National Health Survey Examination reported that there were 3,125,000 adults, aged 18 to 79, with definite coronary heart disease and another 2,410,000 who were suspect. If the results of the studies are applicable to this large population at risk then a major health problem exists.

It should be noted that these studies present no evidence that the exposure to carbon monoxide increases the frequency and severity of chest pain or the development of other complications associated with heart disease. Furthermore, they provide little positive or negative evidence that high ambient CO concentrations in a community are associated with either the prevalence of angina pectoris or the natural history of heart disease. They do, however, permit an inference that such relationships exist and provide a basis for further investigation in this important area.

## Carbon Monoxide Effects on Behavior

The behavioral effects of low concentrations of carbon monoxide are small and variable. Nevertheless, investigations made to date suggest that carbon monoxide does have an effect on human behavior at blood concentrations even lower than in chronic smokers. The effects found most are those on vigilance tasks frequently cited where a higher incidence of missed observations occurred by individuals under exposure to low CO concentrations than under control conditions. The results of some studies suggest that carbon monoxide may have a slight deleterious effect on driving performance. Low concentrations of carbon monoxide may impair brightness discrimination and there are some hints that various verbal and arithmetic abilities as well as motor coordination are lessened.

Carbon monoxide may modify effects produced by other substances. People drive automobiles under the influence of sedatives, tranquilizers, alcohol, antihistamines, and other drugs. What would be innocuous amounts of such drugs if taken alone may become important determinants of behavior in the presence of low carboxyhemoglobin concentrations.

## Carbon Monoxide Effects on the Fetus

It has recently become obvious that the fetus may be extremely susceptible to effects of carbon monoxide carried in maternal blood. Only a few studies have explored the effects of the pollutant on the growth and development of the embryo and fetus, however, those that have evidenced decreased birth weights in newborn babies.

As indicated earlier, CO interferes with the ability of blood and tissue to carry oxygen. This effect operates to compromise oxygen delivery to developing cells. If present briefly at critical periods of embryonic or fetal development or if continued for long periods, these effects may interfere with normal development.

## Carbon Monoxide Effects on Plants

Reducing ambient CO concentrations can have some beneficial effects for particular plants although in general, plants are relatively resistant to carbon monoxide. The apparent photosynthetic rate (an indicator of growth rate) of coleus, cabbage, and grapefruit is inhibited at CO concentrations as low as 1-10 parts per million. Carbon monoxide reduction could result in improved production of these plants where they are grown in urban locations.

# Section-S

# REFERENCES FOR CARBON MONOXIDE CONTROL ANALYSIS

In the course of developing CO control strategies, the following materials were prepared:

Air Quality Maintenance Plan Technical Memorandum 26, "Carbon Monoxide in the San Francisco Bay Area: The Problem and Approach to CO Plan Development," (draft), September 1978.

Barton-Aschman Associates, Inc., "Sensitivity Analysis of Selected Transportation Control Measures: Potential Reductions in Regional Vehicle Miles of Travel," two memoranda to Hanna Kollo, Metropolitan Transportation Commission, July 22, 1977 and August 12, 1977.

Throughout the text of Sections O through R, numbered references refer to the following 14 reports and studies:


Reference 1: Association of Bay Area Governments, "Air Quality Management," Chapter VI, San Francisco Bay Area Environmental Management Plan, Hotel Claremont, Berkeley, CA, June 1978.

Reference 2: Ott, Wayne, and Rolf Eliassen, "A Survey Technique for Determining the Representativeness of Urban Air Monitoring Stations with Respect to Carbon Monoxide," Journal of the Air Pollution Control Association, Volume 23, No. 8, pp. 685-690, August 1973.

Reference 3: U.S. Department of Health, Education, and Welfare, "Air Quality Criteria for Carbon Monoxide," National Air Pollution Control Administration, Publication No. AP-62, Washington, D.C., March 1970.

Reference 4: U.S. Environmental Protection Agency, "Guidance for Air Quality Monitoring Network Design and Instrument Siting, Supplement A, CO Siting," Guideline Series, Office of Air Quality Planning and Standards No. 1.2-012 (revised 6/75)

Reference 5: U.S. Environmental Protection Agency, "Guidelines for Air Quality Maintenance Planning and Analysis, Volume 9: Evaluating Indirect Sources," Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711, EPA-450/4-75-001, January 1975.

Reference 6: 40 CFR 50.1(e); "National Primary and Secondary Air Quality Standards: Definitions," Federal Register 36, p. 22384, November 25, 1971.

Reference 7: Dabberdt, W.F., R.C. Sandys, and P.A. Buder, "A Population Exposure Index for Assessment of Air Quality Impact," Stanford Research Institute, report prepared for California Business Properties Association, July 1974.

Reference 8: de Nevers, N. and J.R. Morris, "Rollback Modeling: Basic and Modified," Journal of the Air Pollution Control Association, Volume 25, No. 9, pp. 943-947, 1975.

Reference 9: Zimmerman, J.R. and R.S. Thompson, "User's Guide for HIWAY: A Highway Air Pollution Model," U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, Pub.No. EPA-650/4-74-008, February 1975.

Reference 10: Ward, C.W. Jr., A.J. Ranzieri, and E.C. Shirley, "Caline 2-An Improved Microscale Model for the Diffusion of Air Pollutants from a Line Source," California Department of Transportation, November 1976.

Reference 11: MacCracken, M.C., and G.D. Sauter, eds., "Development of an Air Pollution Model for the San Francisco Bay Area," final report to the National Science Foundation, Lawrence Livermore Laboratory, UCRL-51920, October 1975.

Reference 12: Lamb, R.G., H. Hogo and L.E. Reid, "Development and Testing of a Lagrangian Approach to Modeling Air Pollutant Dispersion in the Vicinity of a Roadway," Systems Applications, Inc. draft final report prepared for U.S. Environmental Protection Agency, August 1978.

Reference 13: Chenu, D.C., "Micro Analysis of the San Jose Central Business District, an Overview," California Department of Transportation, June 1977.

Reference 14: Kruger, A.J. and A.D. May, "The Analysis and Evaluation of Selected Impacts of Traffic Management Strategies on Freeways," Institute of Transportation and Traffic Engineering, University of California, Berkeley, prepared for U.S. Department of Transportation, October 1976.

# Section-T

# TOTAL SUSPENDED PARTICULATE PROBLEMS IN THE SAN FRANCISCO BAY AREA

This section describes total suspended particulate problems in the Bay Area, and summarizes problems with the existing Bay Area monitoring program.

## BACKGROUND

In 1957 four stations began collecting TSP data in the Bay Area for the National Air Sampling Network (NASN). The air monitoring network has been expanded through the years and presently includes 22 TSP sampling sites. The monitoring program will be described in some detail in a later section.

Various ambient air quality standards for suspended particulate have been exceeded in portions of the Bay Region. On September 9, 1975, EPA identified the area as an air quality maintenance area (AQMA)--an area that has the potential for failing to maintain certain national air quality standards during the 1975-1985 time frame. Particulate matter was one of the designated pollutants for the AQMA. Oxidant and sulfur oxides were also cited (see Reference 2). In a more recent publication (see Reference 3) the EPA has declared that the San Francisco Bay Area Air Basin does not meet the national 24-hour secondary standard for TSP (150 $\mu g/m^3$), and that Alameda County does not meet the national annual primary standard for TSP (75 $\mu g/m^3$ AGM). Thus the Bay Area Air Quality Management Region, or at least parts of it, are non-attainment areas for TSP. Certain counties -- Marin, Napa, San Mateo, Solano, and Sonoma -- have recently been re-designated (Reference 4) as attainment areas for the secondary standard. Four counties remain non-attainment of either the primary or secondary standard.

To comply with the Clean Air Act the State must submit a plan to attain and maintain the national air quality standards for TSP; primary standards within three years and secondary standards within a reasonable time.

## FEDERAL AND CALIFORNIA STANDARDS

The Bay Region is subject to five different particulate standards and one "guideline" (see Reference 5), as shown in Table 49. Through the 21 years of TSP monitoring in the Bay Area, each of these standards has been exceeded somewhere in the air basin. The 24-hour state standard of 100 $\mu g/m^3$ is the most stringent, and is exceeded from time-to-time at several Bay Area Air Quality Monitoring stations. There are a small number of exceedances of the state annual average (60 $\mu g/m^3$ AGM) but almost no violations of the national primary standards (75 $\mu g/m^3$ annual and 260 $\mu g/m^3$ 24-hour). Three factors are mainly responsible for the relatively clean record with respect to the national TSP standards. Two early BAAQMD

regulations controlled open burning and the opacity of particulate emissions. The third factor is the general use of natural gas as an industrial and domestic fuel, rather than oil or coal which produce more particulate. Table 50 gives a summary of the district's particulate monitoring experiences with respect to the various standards.

Ambient concentrations of TSP in the Bay Area show a pattern of low values near the coast increasing with distance inland, particularly into dry sheltered valleys. Figure 62 shows an approximate isopleth map for TSP values in the region. The 1975 annual geometric means are shown for the BAAPCD monitoring network. Highest readings occurred in the Santa Clara and Livermore Valleys. Table 50 emphasizes the position of Livermore as the record holder for most TSP exceedances. Because of the high concentrations observed there, the Livermore monitoring station has been the subject of much study. It appears that the site location, near an unpaved commercial lot, combined with intermittent construction at nearby sites, resulted in very localized TSP hot spots. These effects will be discussed in detail in Section U of this chapter.

In addition to the six concentration standards listed in Table 49, there is a State visibility standard. "Visibility reducing particles" should not be present in sufficient amount to reduce the prevailing visibility to less than 10 miles when the relative humidity is less than 70%. The BAAQMD routinely compiles visibility and humidity data from five major airports where hourly readings are taken. In 1976 there were 154 days of poor visibility (as defined) in San Jose but only 72 in Fairfield. For 1977 the results were 135 and 34 days, respectively. The State visibility standard is exceeded frequently at all five study sites. Visibility data (days over standard) are compiled in Table 3 for recent years.

## BAY AREA MONITORING PROGRAM

The ambient air monitoring system in the Bay Area includes BAAQMD stations and NASN stations. In addition to the permanent network, there are scattered industrial monitors, airport monitors, private, academic and government research projects. With one important exception, only the permanent network results will be considered here. The outside data are difficult to obtain, usually of short-term or intermittent coverage, and may include non-standard sampling equipment or procedures. Outside data are cited for one purpose in this report, to show background TSP levels in the sense of 40 CFR §51.13(c); because no comparable data are available from the permanent urban air monitoring network.

### Monitoring Sites and Procedures

Even the permanent network, unfortunately, is not exactly permanent. The system started with four NASN sites in 1957, expanded through the years to 25 stations in 1978, but will drop to 23 stations at the end of 1978. This last decrease is the result of closing two NASN sites (Oakland and San Francisco) in mid-1978. In addition to the variation in number of stations, there have been some changes in location necessitated by space requirements, lease arrangements, and other factors. Since TSP concentration patterns are very localized, a change in the station location can have substantial effects on the monitoring record.

Table 49. Ambient Air Quality Standards for Suspended Particulates

| Averaging Time | California Std.[1] | National Standards[2] | |
|---|---|---|---|
| | | primary[3] | secondary[4] |
| 24-hour[5] | 100 $\mu g/m^3$ | 260 $\mu g/m^3$ | 150 $\mu g/m^3$ |
| 1-year[6] | 60 $\mu g/m^3$ | 75 $\mu g/m^3$ | 60 $\mu g/m^3$ |

(The high volume sampler[7] is the accepted test method.)

[1] California standards should not be equalled or exceeded at any time.

[2] National standards, other than annual averages, are not to be exceeded more than once per year.

[3] National primary standards are the levels of air quality necessary, with an adequate margin of safety, to protect the public health. Each state must attain the primary standards no later than three years after the implementation plan is approved by the EPA.

[4] National secondary standards are the levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after the implementation plan is approved by the EPA.

[5] The 24-hour average is obtained by weighing the total particulate catch on a filter from a continuous 24-hour sampling period.

[6] The annual geometric mean (AGM) is the $n$-th root of the product of the $n$ 24-hour readings; or equivalently, the antilog of the (arithmetic) average logarithm of the individual readings.

[7] EPA method specified in Federal Register, Volume 36, Number 84, Friday, April 30, 1971, p 81, or 40 CFR 50.6, 50.7 and Appendix B.

[8] The 60 $\mu g/m^3$ AGM is not strictly a national standard, but rather a "guideline" to attainment of the 24-hour secondary standard of 150 $\mu g/m^3$.

Table 50. Summary of TSP Monitoring Data in the Bay Area, 1972 - 1978

| Averaging Time | Standard ($\mu g/m^3$) | | - Year - 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978** |
|---|---|---|---|---|---|---|---|---|---|
| 24 hr | 100 state | number of stations with $\geq$ 1 excesses | 6 | 15 | 16 | 15+ | 19+ | 15+ | 7+ |
| | | % of sampling days over std., highest station | 17(L)* | 23(P) | 23(L) | 23(L) | 41(L) | 19(L) | 16(L) |
| 24 hr | 150 national secondary | number of stations with >1 excess | 1 | 7 | 10 | 12 | 18 | 8 | 4 |
| | | % of sampling days over std., highest station | 1(L) | 3(L) | 5(L) | 13(L) | 11(L) | 2(L) | 1(B) |
| 24 hr | 260 national primary | number of stations with >1 excess | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| | | % of sampling days over std., highest station | -- | -- | 1(v) | -- | 2(c) | -- | -- |
| annual (AGM) | 60 state std. and national sec. "guideline" | number of stations over standard | 1 | 3 | 1 | 2 | 12 | 3 | 1 |
| | | highest station value (station) | 67(L) | 66(L) | 71(L) | 80(L) | 85(L) | 68(L) | 62(L) |
| annual (AGM) | 75 national primary | number of station over standard | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| | | highest station value (station) | -- | -- | -- | 80(L) | 85(L) | -- | -- |
| Total*** number of stations in network | | | 15 | 17 | 18 | 19 | 19 | 20 | 18 |

*Station identifier: (L) = Livermore, (c) = Concord, (v) = Vallejo, (P) = Pittsburgh, (B) =Burlingame.
**Partial year data, January through June, 1978.
***Total number of sampling sites, including BAAPCD stations and NASN sites, with sampling at one site for entire calendar year.

Table 51 Days per Year When Visibility Was Less than State Standard (10 miles with relative humidity less than 70%)

| Airport | Year 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978[1] |
|---|---|---|---|---|---|---|---|
| San Francisco[2] | 138 | 108 | 119 | 129 | 172 | 123 | (30) |
| Oakland | 92 | 57 | (75) | 77 | 96 | 95 | (30) |
| San Jose | 145 | 109 | 144 | 128 | 154 | 135 | (38) |
| Travis[3] (Fairfield) | (15) | 27 | 57 | 38 | 72 | 34 | (8) |

[1]Data through June, 1978.
[2]San Franicscso International Airport, about 5 miles south of the City of San Francisco.
[3]Travis Air Force Base.
( )Parentheses indicate incomplete data base. True annual value would be greater than shown.

Table 52. Bay Area TSP Monitoring Sites -- Permanent Network

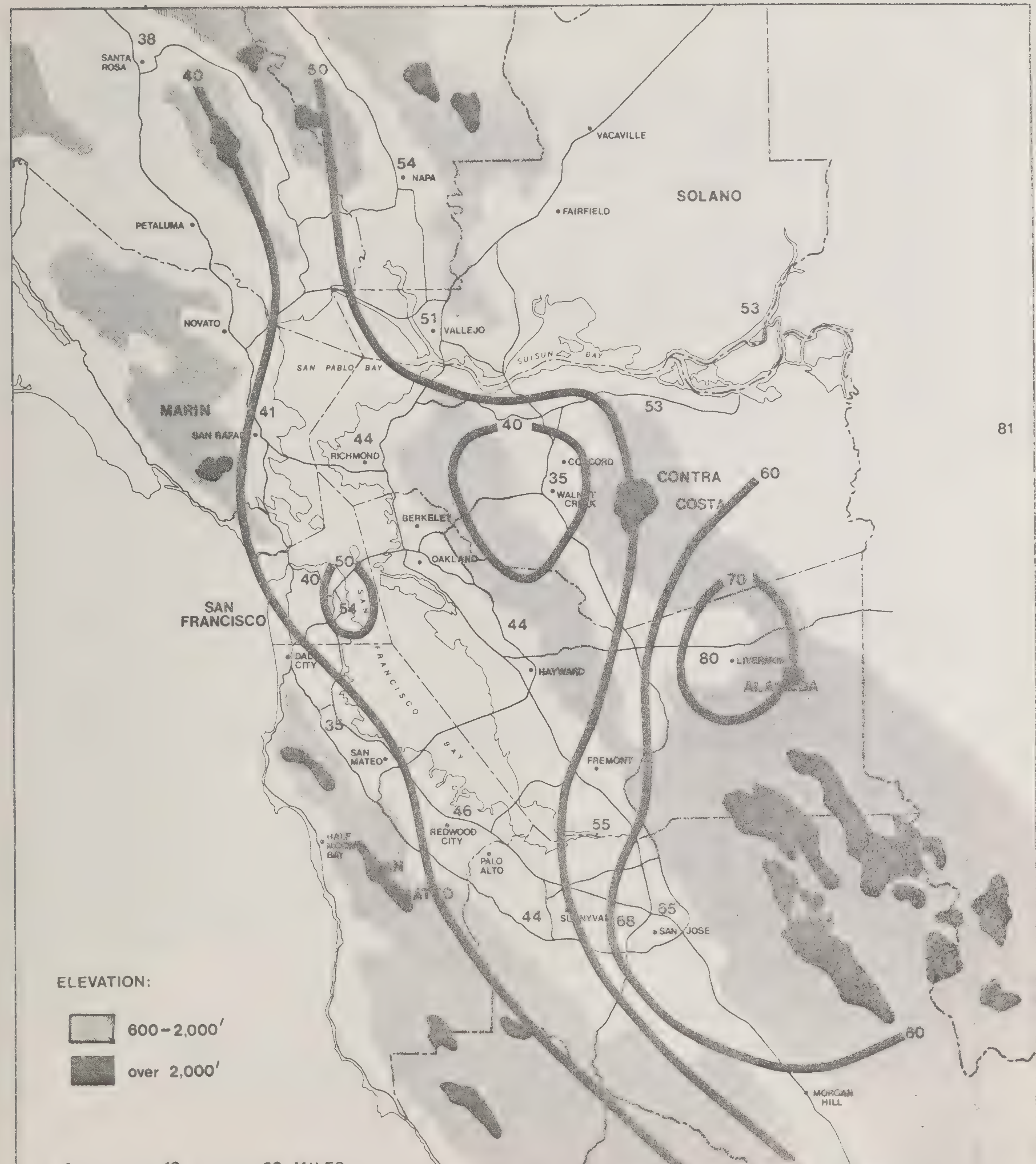
| Street Address | City | (1) Location | (2) Dom. Infl. | (3) Traffic Type | (4) Non-Compl. |
|---|---|---|---|---|---|
| BAAPCD Sites | | | | | |
| 939 Ellis Street | San Francisco | CC | COM | COM | R |
| 900 23rd St (Potrero) | San Francisco | CC | IND | FWY | |
| 4984 Cabrillo Hwy. | Pacifica | SU | REC | ART | L |
| 534 Fourth Street | San Rafael | CC | COM | COM | |
| 1144 13th Street | Richmond | SU | IND | ART | |
| 583 W. Tenth Street | Pittsburg | SU | IND | COM | |
| 991 Treat Blvd. | Concord | SU | RES | ART | L |
| 40733 Chapel Way | Fremont | SU | COM | COM | |
| 2131 Railroad Ave. | Livermore | CC | COM | COM | |
| 120 N. Fourth St. | San Jose | CC | COM | COM | |
| 7671 Monterey St. | Gilroy | CC | COM | COM | |
| 251 Murphy Ave. | Sunnyvale | SU | COM | COM | |
| 12333 S. Saratoga Rd. | Saratoga | SU | COM | ART | |
| 897 Barron Avenue | Redwood City | SU | COM | COM | |
| 1229 Burlingame Ave. | Burlingame | CC | COM | COM | |
| Millbrae Ave & Rt.101 | Millbrae | SU | VEH | FWY | L |
| 437 Humboldt St. | Santa Rosa | CC | COM | COM | |
| 2552 Jefferson St. | Napa | CC | COM | ART | |
| 304 Tuolumne St. | Vallejo | CC | COM | ART | |
| 2220 Moore Park Ave. | San Jose | CC | VEH | ART | |
| 1111 Jackson | Oakland | CC | COM | COM | H |
| NASN Sites | | | | | |
| 120B N. Fourth St. | San Jose | CC | COM | COM | |
| 499 Fifth Street | Oakland | CC | COM | FWY | * |
| 101 Grove Street | San Francisco | CC | COM | COM | * |
| 2151 Berkeley Way | Berkeley | SU | COM | ART | * |

(1) Location: CC = center city, SU = suburban, RU = rural.

(2) Dominating Influence: COM = commercial, RES = residential IND = industrial, VEH = vehicular, NU = near urban, AGR = agricultural, REC = recreational area (seacoast in this case).

(3) Traffic Type: COM = commercial, RES = residential IND = industrial, FWY = freeway, ART = arterial.

(4) Non-complying factors, based on proposed EPA guidelines -- Federal Register, Vol. 43, No. 152 -- Monday, August 7, 1978.
H = too high (>15 meters above grade).
R = restricted by wall or barrier.
* = unknown.
L = too low (<2 meters).




**1975 Annual Geometric Means of Total Suspended Particulate in $\mu g/m^3$ (by hi-volume method with fiberglass filters). Federal primary standard is 75 $\mu g/m^3$. State standard is 60 $\mu g/m^3$.**

Figure 62

Table 52 is a list of TSP monitoring sites in the Bay Area for the period of 1972-1978. Though the network has changed slightly through the years, the problem stations -- Livermore, San Jose, and Fremont -- where most excesses occur, have been operating in the same locations through the study period of 1973-77.

Monitoring Procedures. TSP concentrations are calculated by weighing the filter catch from a 24-hour run of a hi-volume sampler. The method and apparatus have been in routine use for years, though shortcomings have been recognized and, in some cases, minimized. Flow rate, siting, filter composition, and relevance of the TSP value to health have all been questioned.

BAAQMD samplers are run from 3 p.m. to 3 p.m. every third day or every sixth day. Readings for submittal to ARB and EPA are collected on glass filters and synchronized with the EPA six-day schedule. Some samples -- alternate days at some stations, or duplicates at Pittsburg and San Jose -- are collected on cellulose (paper) filters for comparison purposes and possible silicate analysis. (As noted in Reference 6, comparisons over a 4-year period indicate that glass fiber results average 7.5% higher than cellulose fiber results.) BAAQMD hi-vols are fitted with constant flow controllers, to maintain a flowrate of about 30 cfm throughout the 24-hour sampling period. The pressure drop across the filter is used to vary the voltage to the blower motor to keep the air-flow nearly constant, whether the filter is clean or loaded.

NASN samplers are run midnight to midnight on a national sampling schedule with readings every sixth day (every twelfth day before 1976). Glass fiber filters are used and flow rate is the arithmetic average of a pre-sample reading and a post-sample reading.

Limitations of the Monitoring Data Particle Size. The fundamental limitation of the TSP data is its relevance to the protection of public health and welfare. It has been known for years that the smallest particles, say 0.1 to 1.0 μ, present the greatest threat to health, because these are carried deep into the lungs. The TSP measurement, by contrast, is strongly influenced by the concentration of large particles, though the sampler housing design may exclude those over 100 μ.

Friedlander (see Reference 7), for example, found that:

> Total weight is an inadequate measure of particulate pollution and its effects. Particles in the 0.1 to 1 μ range generally have a much greater impact on public health, visibility, and cloud nucleation...

and further:

> It is quite possible that total particulate mass may be decreasing...while air quality declines because the mass of material in the submicron range increases. Just such a development may have been taking place in Los Angeles....

Friedlander points out that the most common particulate control methods, mechanical and electrostatic, seem to have a minimum efficiency in the 0.1 to 1 μ range. Thus large reductions in total mass emissions may still leave dangerous amounts of small particles in the effluent and the ambient air.

The EPA has invested considerable effort in recent years to develop a fine particle air quality standard, with a supporting sampling method. The so-called dichotomous samplers are past the development stage and commercial availability is expected soon. But the overall transition to a fine particle approach to air quality is still 18 months to two years away, according to EPA sources.

It seems clear that a fine particle standard will be adopted in the future, with new sampling devices and techniques. Most importantly, this will require a new review of health effects, sources, attainment status, and control programs to meet the new standards. Meanwhile, the inertia of years of hi-vol data requires preparation of a plan to attain the present TSP standards.

Chemical Composition. A second limitation of TSP data is the lack of composition information. The routine TSP sampling procedure provides no clue to the sources contributing to a given receptor, nor the possible health effects of the particulate mix. Primary and secondary, man-made and natural, harmful and benign components may be present in any proportion. Sulfates, for example, have been recognized as especially harmful and irritating to humans. The State of California has adopted sulfate and lead standards to control two possible components of the particulate burden. Various studies have been made to elucidate at least the average composition of urban dusts. Results are mixed, with some research indicating substantial amounts (26 to 42%) (see Reference 8) of natural components such as soil and sea salt. Grosjean (see Reference 9) has studied secondary organic aerosols, resulting from photochemical processes. Novakov's group at the Lawrence Berkeley Laboratory has studied primary carbonaceous matter (soot) from stationary and mobile sources, elemental composition of TSP, and $SO_2$/sulfate conversion (see Reference 10). Another group at U.C. Davis has been very active in size and elemental analysis of particulate matter (see Reference 11).

A great deal of information is now available on the composition of particulate matter from selected sites, but the knowledge is generally not transferable over time or over space, except as order of magnitude estimates. A study of limited composition data from Bay Area Stations has been published (see Reference 12) and the results will be considered in Section B of this report.

Siting. In the past, ambient air monitoring stations were set up on the basis of some *a priori* judgments of air quality problems and on the availability of space and labor. The Air Quality Management District office building, other public buildings, and available rentals often determined the sampling sites. Since TSP measurements are so sensitive to large particles, and since the presence of large particles is so dependent on local conditions, the extreme values in a TSP record are, to a great extent, the result of local fugitive

dust. One experimental BAAQMD monitor (Pacifica) is near the seacoast, with no industrial sources in the vicinity and little anthropogenic contribution. The natural local sources, however, produce the highest TSP readings in the region. At inland sites, an unpaved parking lot, construction, or demolition near a monitoring site will influence TSP readings much more than the average small particle content which is actually more harmful. Livermore, for example recorded an extreme value of 601 $\mu g/m^3$ on January 30, 1976, because of construction in an adjacent area. EPA has recently proposed guidelines (see Reference 13) for the siting of air quality monitors, including particulate, which attempt to minimize -- or at least standardize -- siting effects. Such guidelines are desirable and will be beneficial if the responsible agencies can support the cost of implementation. Still more beneficial, however, would be the changeover to a fine particle standard, which would nearly eliminate the (large size) fugitive dust interference/siting problem.

Flow Rate. The flow volume measurement is probably the chief source of error in hi-vol data, though filter handling and conditioning also introduce some uncertainty. Several approaches to flow-measurement have been tried, including constant flow, pre-/post-sample measurement, continuous recordings, and limiting orifice. None have proven completely satisfactory; side-by-side samples give results which differ by several percent.

Filter Composition. Cellulose and glass fiber filters are the most common collecting media, though more exotic materials may be required for certain analytical techniques. Cellulose was used in early monitoring efforts and has been retained for certain kinds of chemical analysis, especially silicate. Glass fiber filters have been standard in recent years, probably because the fiber does not absorb water and is thus less sensitive to humidity and (variations in) sample conditioning. Some claim that the basic nature of glass, and/or the binders used in manufacture, interact with acid gases to produce artefact TSP.

# Section-U

# TSP PROBLEMS, CAUSES AND FUTURE PROSPECTS

This section describes total suspended particulate problems, existing control programs and future particulate problems.

PROBLEM DEFINITION

The latest designations show Alameda County as a non-attainment area for the total suspended particulate (TSP) primary standard (75 $\mu g/m^3$ AGM). Contra Costa, Santa Clara, and San Francisco counties are non-attainment areas with respect to the 24-hr secondary standard of 150 $\mu g/m^3$. A compilation of TSP monitoring values >150 $\mu g/m^3$ is shown in Table 53 of this plan section. Data are listed by individual station for 1975, 1976, and 1977, with available 1978 results.

## Historical Air Quality Trends

BAAQMD meteorologists analyzed eight years of TSP monitoring data (1969-1976) and published a report (see Reference 6) in which they concluded:

a. A slight downward trend in this 8-year period was overshadowed by weather-induced fluctuations.

b. Anomalies at individual stations are frequently associated with nearby construction activities.

c. The three excesses of the Federal 75 $\mu g/m^3$ AGM standard were all associated with highway construction.

Table 2 summarizes TSP data available for the eight most recent years, with 1978 data incomplete as of October 1978. During these years the national 75 $\mu g/m^3$ AGM standard was exceeded only at Livermore in 1975 and 1976. The results were borderline with AGMs of 74 in 1972 and 1974 but lower in 1973, 1977 and, so far, in 1978.

## Meteorological Effects

1976 was clearly the worst year for TSP, with two related meteorological factors contributing. First, the extreme drought conditions that plagued the northwestern states in 1976 and 1977 produced greater quantities of fugitive dust. Second, the stagnant weather conditions associated with the drought did not provide the air ventilation that normally disperses pollutants. November and December of 1976 were especially bad for TSP. In fact 71% of the 1976 readings 150 $\mu g/m^3$ were recorded in the last two months of the year (see Reference 14). Mean wind speeds were less than half of normal and were the lowest in 15 years of record. November

and December of 1976 produced 34 days with stability factors* greater than 12°F. Subsidence and radiation inversions combined to produce very restrictive surface-based stability. Of the 16 sampling days during the two-month period, 13 were days with temperature inversions, producing a flurry of high TSP measurements. For the normally rainy month of December, there were only two days with measurable precipitation. January 1976 also produced several excesses of the secondary standard. And, from the limited Bay Area data for remote sites, a value of 101 $\mu g/m^3$ was recorded (see Reference 15) on January 31 in the Montezuma Hills, several miles from any industrial or vehicular sources.

December of 1975 was similar to December of 1976 with respect to dry, stagnant conditions, but not quite so extreme in the stabilities observed. December 1975 had only 10% of normal presipitation and had 13 days with stability factors >12°F, compared to 23 in 1976. Out of 10 sampling days in December 1975, Livermore posted 9 TSP values above 100 $\mu g/m^3$. Again fugitive dust from nearby highway construction combined with restrictive meteorology to produce high local concentrations.

The drought years had an extra disadvantage, in that source operators who wanted to control fugitive dust (by watering) were unable to obtain water supplies for that purpose.

Emission Inventory

The BAAQMD Source Inventory for particulate matter is shown in Table 54 for the years 1972 through 1978, with 1975 as the baseline calculation year. The table is a summary form, showing only seven source categories. More detailed breakdowns are available (see Reference 16), but this version provides sufficient detail for the present purposes.

The source inventory totals for the period shown have decreased about 15%, mainly in the burning of materials and motor vehicle categories, but future projections show an increase to 210 tons/day for 1985 and 250 tons/day for 2000. The particulate inventory totals used in the Air Quality Management Plan (see Reference 1) differ slightly from the BAAQMD inventory because of a different calculation of mobile source emissions. The AQMP particulate totals are 169, 192 and 225 tons/day for 1975, 1985 and 2000 respectively. The major increases for future years come from combustion of fuels and aircraft emissions. These increases seem largely unavoidable, with fuel switching from gas to oil, and inevitable growth of air travel and transport.

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* Stability factor, as calculated at the BAAQMD, is temperature (°F) at 2500 feet minus surface temperature, from Oakland, Vallejo or San Jose. Higher (positive) values indicate stronger low-level inversions and decreased vertical mixing.

Table 53. 24-hr Average TSP Values >150 $\mu g/m^3$ by Station and Date - 1975

| 1975 | DISTRICT STATIONS | | | | | | | | | | | | | | | | | | | | | | NASN STATIONS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SF | PO | SR | RI | PT | CC | FR | LI | SJ | GI | SU | SA | RC | BU | ST | NP | VA | PA | MB | WSJ | SJ AIRPT | NORTH SJ AIRPT | BE | OA | SF | SJ |
| Jan 12 | | | | | | | | | | | | | | | | | | | 181† | | 155 | | | | | |
| 15 | | | | | | | | | | 152 | | | | | | | | | | | 187 | | | | | |
| 18 | | | | | | | | | | 172 | | | | | | | | | | | 201 | | | | | 177 |
| 21 | | | | | | | | | | | | | | | | 157 | | | | | | 204 | | | | |
| 24 | | | | | 180 | | | 155 | | 175 | | | | | | | | | | | 173 | 166 | | | | |
| Feb | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mar 25 | | | | | | | | | | | | | | | | | | | 167 | | | | | | | |
| 28 | | | | | | | | | | | | | | | | | | | 248 | | | | | | | |
| Apr | | | | | | | | | | | | | | | | | | | | | | | | | | |
| May 18 | | | | 161 | | | | | | | | | | | | | 151 | | | | | | | | | |
| Jun | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jul 29 | | | | | | | | | | | | | | | | | | | 155 | | | | | | | |
| Aug 22 | | | | | | | | 180 | | | | | | | | | | | | | | | | | | |
| 28 | | | | | | | | 174 | | | | | | | | | | | | | | | | | | |
| Sep 24 | | | | | | | | 178 | | | | - not open - | | | | | | - not open - | | | no data | no data | none >150 | none | none | |
| Oct 6 | 275* | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nov 2 | | | | | | | | | | | | | | | | | 201 | | | | | | | | | |
| Dec 2 | | | | | | | 169 | 166 | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | 160 | | | | | | | | | | | 188 | | | | | | | |
| 8 | | | | | | | 173 | | | | | | | | | | | | | | | | | | | 163 |
| 14 | | | | | | | | 152 | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | 166 | | | | | | | | | | | 171 | | | | | | | |
| 29 | | | | | | | | 167 | | | | | | | | | | | | | | | | | | |
| Primary | - none - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Secondary | | | | | | | x | x | | x | | | | | | | x | | x | | x | x | | | | x |
| AGM (BAAPCD)** | 49 | | 30 | 35 | 44 | 31 | 49 | 69 | 58 | 51 | 39 | | 42 | 33 | 44 | 54 | 51 | | | | | | | | | |
| AGM (ARB)*** | 49 | 54 | 41 | 45 | 53 | 34 | 55 | 80 | 65 | 56 | 44 | | 46 | 35 | 38 | 55 | 59 | | | | | | | | | |
| AGM (NASN) | | | | | | | | | | | | | | | | | | | | | | | <39 | <48 | <53 | <72 |
| Primary AGM | | | | | | | | x | | | | | | | | | | | | | | | | | | |

†Monthly summary note "excavation in adjacent area."
*"New roof being installed on adjacent building."

**BAAPCD AGM values based on approx. 120 samples, glass fiber and cellulose filters.
***ARB calculation of AGM, approx. 60 samples, glass fiber filters.

| | | DISTRICT STATIONS | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1976 | SF | PO | SR | RI | PT | CC | FR | LI | SJ | GI | SU | RC | BU | ST | NP | VA | PA | MB | WSJ | OA |
| Jan 16 | | 151 | | | | | | | | | | | | | | | | | | |
| 19 | | 152 | | | | | | | | | | | | | | | | | | |
| 24 | | | | | | | | 246 | 159 | | | | | | | | | | | |
| 27 | | | | | | | | 198 | | | | | | | | | | | | |
| 30 | 166 | 170 | | | | 171 | | 601* | | | | | | | | | | 288 | | |
| Feb | | | | | | | | | | | | | | | | | | | | |
| Mar | | | | | | | | | | | | | | | | | | no data | | |
| Apr | | | | | | | | | | | | | | | | | | | | |
| May | | | | | | | | | | | | | | | | | | | | |
| Jun 22 | | | | | | | | | 152 | | | | | | | | | | | |
| 28 | | | | | | | | 155 | | | | | | | | | | | | |
| Jul 22 | | | | | 158 | | | | | | | | | | | | | | | |
| Aug | | | | | | | | | | | | | | | | | | | | |
| Sep 2 | | | | | | | | 170 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | - not open - | 190 | | |
| Oct 5 | | | | | | | | | | | | 173 | | | | | | | | |
| 20 | | | | | | | 153 | | | | | | | | | | | | | |
| Nov 1 | | 155 | | | 204 | | | 166 | | | | | | | | 176 | | | | |
| 7 | | 159 | | | | | | 152 | | | | | | | | | | | | |
| 25 | | | | | | | | 156 | | | | | | | | | | | | |
| Dec 1 | | | | | 168 | | | | | | | | | | | | | | | |
| 4 | | | | | | | 156 | | | | | | | | | | | | 162 | |
| 7 | | 164 | | | 158 | | 152 | | 175 | | | | | | | | | Nov/Dec - no data | | |
| 13 | | | | | | | | | | | | | | | | | | | 167 | |
| 16 | | | | | | | 183 | 180 | | | | 207 | | | | | | | | |
| 19 | | | | | | | 163 | | | | | | | | 167 | | | | | |
| 25 | | | 170 | 163 | 175 | 265 | 200 | 171 | 155 | | 166 | 244 | | | | | | | | |
| 28 | | | | | | 156 | 162 | 160 | | | | 182 | | | 173 | | | | | |
| Primary | - none - | | | | | | | | | | | | | | | | | | | |
| Secondary | | x | | | x | x | x | x | x | | | x | | | x | | | x | x | |
| AGM(BAAPCD)** | 55 | 62 | 36 | 48 | 61 | 51 | 62 | 85 | 71 | 62 | 50 | 59 | 49 | 66 | 65 | 52 | | | | |
| AGM(ARB)*** | 53 | 63 | 40 | 58 | 66 | 52 | 61 | 87 | 75 | 62 | 50 | 57 | 41 | 45 | 61 | 52 | | | | |
| Primary | | | | | | | | x | | | | | | | | | | | | |

| | NASN STATIONS | | | |
|---|---|---|---|---|
| 1976 | BE | OA | SF | SJ |
| Jan | none | | | |
| 31 | | | | 155 |
| Feb | | | | |
| Mar | | | | |
| Apr | | | | |
| May | | | | |
| Jun | | | | |
| Jul | | | | |
| Aug | | | | |
| Sep | | | | |
| Oct | | | | |
| Nov 2 | | 167 | 163 | 213 |
| 8 | | 166 | 211 | 214 |
| Dec 2 | | | | 211 |
| 14 | | | | 239 |
| 20 | | | | 215 |
| 26 | | | 168 | 243 |
| Secondary | | x | x | x |
| AGM(NASN) | 41 | 55 | 47 | 71 |

*Data sheet note "construction in adjacent area."
**District calculation of AGM, approx. 120 samples on cellulose and glass fiber.
***ARB calculation of AGM, approx. 60 samples, glass fiber only.

Table 53. (cont.) 24-hr Average TSP Values >150 μg/m³ by Station and date - 1977

| 1977 | SF | PO | SR | RI | PT | CC | FR | LI | SJ | GI | SU | RC | BU | ST | NP | VA | PA | MB | WSJ | OA | NASN STATIONS BE | OA | SF | SJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DISTRICT STATIONS | | | | | | | | | | | | | | | | | | | | | | | |
| Jan 9 | | | | | | | | | | | | 174 | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | | 153 |
| Feb 14 | | | | | | | | | | | | | | | | | not | 161 | | | | | | |
| Mar | | | | | | | | | | | | | | | | | open | | | | | | | |
| Apr 12 | | | | | | | | | | | | | | | | | | 161 | | | | | | |
| May | | | | | | | | | | | | | | | | | | | | | | | | |
| Jun 23 | | | | | | | | | | | | | | | | | 256 | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | 206 | | | | | | | |
| 29 | | | | | | | | | | | | | | | | | 188 | | | | | | | |
| Jul 29 | | | | | | | | 179 | | | | | | | | | * | | | | - none - | - none - | - none - | |
| Aug 1 | | | | | | | | | | | | | | | | | 257 | | | | | | | |
| 22 | | | | | | | | | | | | | | | | | 193 | | | | | | | |
| 25 | | | | | | | | | | | | | | | | | 174 | | | | | | | |
| 28 | | | | | | | | | | | | | | | | | 561 | | | | | | | |
| Sep 6 | | | | | | | | | | | | | | | | | 169 | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | 242 | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | 206 | | | | | | | |
| 30 | | | | | | | | | | | | | | 185 | | | 227 | | | | | | | |
| Oct 9 | | | | | | | | | | | | | | | | | 156 | 156 | | | | | | |
| 12 | | | | | | | | | | 161 | | | | | | | 237 | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | 285 | | | | | | | |
| 24 | | | | | | | | | | | | | | | | | 501 | | | | | | | |
| 27 | | | | | | | | | | | | | | | | | 166 | | | | | | | |
| Nov 2 | | | | | | | | | | | | | | | | | 323 | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | 286 | 174 | | | | | | |
| 14 | | | | | | | | | | | | | | | | | 279 | | | | | | | |
| 17 | | 188 | | | | | | | | | | | | | | | 227 | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | 238 | | | | | | | |
| 29 | | | | | | | | | | | | | | | | | 464 | | | | | | | |
| Dec 20** | 1192 | 1173 | 1071 | 1817 | 2745 | 688 | 870 | 1130 | 810 | 1003 | 425 | 699 | 968 | | 2552 | 3271 | | 1295 | 742 | 1332 | | | | |
| 28 | | | | | | | | | | | | | | | | | 163 | | | | | | | |
| AGM (BAAPCD) | 41 | 56 | 34 | 51 | 54 | 49 | 60 | 68 | 64 | 62 | 45 | 52 | 34 | 35 | 53 | 42 | | | | | | | | |
| AGM (ARB) | - not available - | | | | | | | | | | | | | | | | | | | | | | | |
| AGM (NASN) | | | | | | | | | | | | | | | | | | | | | 40 | 49 | 44 | 72 |

*No data available.
**Bakersfield dust storm.

Table 53. (cont.) 24-hr Average TSP Values >150 μg/m³ by Station and date 1978

| 1978 | DISTRICT STATIONS SF | PO | SR | RI | PT | CC | FR | LI | SJ | GI | SA | RC | BU | ST | NP | VA | PA | MB | WSJ | OA | NASN STATIONS BE | OA | SF | SJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 1 | | | | | | | | | | | | | | | | | | 330 | | | no reading >150 during 1st or 2nd quarters | no reading >150 first quarter | | no reading >150 during 1st or 2nd quarters |
| Feb 18 | | | | | | | | | | | | | | | | | 176 | | | | | | | |
| Mar 23 | | | | | | | | | | | | | | | | | 235 | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | 235 | | | | | | | |
| Apr 1 | | | | | | | | | | | | | | | | | 266 | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | 252 | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | 378 | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | 247 | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | 177 | | | | | | | |
| May 1 | | | | | | | | | | | | | | | | | 356 | | | | | | | |
| 7 | | | | | | | | | | | | | 175 | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | 266 | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | 195 | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | 192 | | | | | | | |
| 22 | | | | | | | | | | | | | | | | | 298 | | | | | | | |
| Jun 3 | | | | | | | | | | | | | | | | | 208 | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | 208 | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | 166 | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | 362 | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | 205 | | | | | | | |
| 24 | | | | | | | | | | | | | | | | | 259 | | | | | | | |
| 30 | | | | | | | | | | | | | | | | | 185 | | | | | | | |
| Jul 6 | | | | | | | | 190 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | 188 | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | 265 | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | 170 | | | | | | | |
| 30 | | | | | | | | | | | | | | | | | 272 | | | | | | | |
| Aug 5 | | | | | | | | | | | | | | | | | 216 | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | 326 | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | 241 | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | 255 | | | | | | | |
| 29 | | | | | | | | | | | | | | | | | 206 | | | | | | | |
| Primary | | | | | | | | | | | | | | | | | x | | | | | | | |
| AGM (BAAPCD)* | 38 | 47 | 33 | 47 | 54 | 39 | 52 | 63 | 58 | 52 | | 45 | 33 | 33 | 48 | 37 | | | | | | | | |
| Primary AGM | | | | | | | | | | | | | | | | | x | | | | | | | |

*Through July 1978.

Table 54. Source Inventory (Summary) for Particulate Matter (1975 base-year)

Tabled values: particulate emissions, (tons/day) annual average

| Source Category | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|---|---|---|
| Petroleum refining | 6 | 6 | 3 | 3 | 3 | 3 | 4 |
| Chemical | 8 | 8 | 5 | 5 | 5 | 5 | 5 |
| Other industrial/commercial | 80 | 77 | 76 | 75 | 76 | 77 | 78 |
| Combustion of fuels | 16 | 17 | 16 | 16 | 23 | 21 | 24 |
| Burning materials | 30 | 19 | 13 | 13 | 13 | 13 | 13 |
| Off-highway mobile sources | 5 | 5 | 5 | 5 | 5 | 6 | 6 |
| Aircraft | 10 | 10 | 9 | 9 | 8 | 9 | 9 |
| Motor vehicles | 53 | 54 | 55 | 49 | 48 | 47 | 47 |
| Total | 208 | 196 | 182 | 175 | 181 | 181 | 186 |

Year columns are headed "- Year -" on the page.

Major improvements in the particulate inventory occurred between 1958 and 1970, as BAAQMD regulations controlled agricultural burning, opacity and incineration. The 1958 total of 420 tons/day was reduced by 50% to 210 tons/day by 1970. The most striking reductions were 70 tons/day in "other industrial/commercial" between 1960 and 1961, and 46 tons/day in "burning of materials" between 1969 and 1970.

The major weakness in source inventory considerations, is the limited data on fugitive dust. As mentioned previously, it is fugitive dust that is largely responsible for TSP values, especially the extreme values. The most striking example was a group of readings taken on December 20/21 in 1977 when the Bakersfield dust storm reached Bay Area monitors. Eleven stations produced readings above 1000 $\mu g/m^3$ with a high of 3300! (This episode is excluded from compliance considerations, as allowed by SIP regulations.) More common are local dust storms, often from construction or demolition sites, which affect only one monitor. None of those are included in source inventory calculations.

There is some potential now to develop at least an annual average inventory for some fugitive dust sources. An EPA publication (see Reference 17) provides a summary of some methods to estimate particulate emissions from unpaved roads, agricultural fields, construction sites, storage piles, etc. An attempt will be made to incorporate these sources into the existing inventory, but there are several problems to consider: the limited data bases, geographical transfer effects, and new data required (silt content of soil, Thornthwaite index, rainfall days, crop type acreage, etc.) This will clearly be an extensive project, but useful for long-term modeling with respect to the secondary standard. For attainment of the primary standard, we will have to rely on the monitoring record and qualitative judgment of local source variations.

The present inventory may provide clues for control of chronic contributors to the TSP burden, but the Bay Area has already controlled these regular stationary sources over the past two decades. In fact, if one sees a steady plume in the Bay Area today, it is almost certainly one of the following three:

a) agricultural burning by permit on a "burn day" -- an announced day with meteorology to disperse pollutants,

b) a white steam plume, with water vapor condensing in cooler atmospheric air, or

c) an accident -- a structural fire or industrial breakdown.

Several companies are carried on the 1975 Source Inventory (see Reference 16) at particulate levels that could total more than 100 tons/year. These are compiled in Table 55. It is noteworthy that none of these major sources is located near the Livermore monitor.

In general, BAAQMD Regulation 2, §6112.2 prohibits any single source operation from emitting more than 40 lb/hr of particulate matter. (A source may emit more than 40 lb/hr only if the p.m. loading is below certain specified low levels, §6112.3.) The 40 lb/hr is equivalent to about 0.5 tons/day or 175 tons/year. Most of the companies in Table 6 have several separate source operations contributing to the emission totals shown.

Compared to the 1975 source inventory total (Table 54) of 175 tons/day, the major sources in Table 55 sum to only 14.6 tons/day or 8.3% of the inventory. Much of this is from combustion of fuels.

Motor vehicles and industrial/commercial categories contain the largest entries in the particulate inventory. Mobile source emissions are not under local jurisdiction, but depend rather on State and Federal regulations. It is estimated that particulate emissions from motor vehicles would be reduced by about 8 tons/day by 1985 (see Reference 18), primarily due to lower exhaust emissions from catalyst vehicles. Tire dust presumably is a function of vehicle miles travelled (VMT), and not much subject to control.

Stationary source contributions can be examined in more detail in Table 56 where 1975 and 1985 estimates are presented for comparison. Included in Table 56 are the 1975 distribution percentages for major point sources and area sources. "Area sources" includes small point sources whose emissions were not calculated on an individual basis. The reader may note from Table 56 that only three source categories have emissions more than 10 tons/day. These are No. 15 Stone, Sand, Gravel, No. 18 Farming, and No. 22 Other Industrial/Commercial. Category No. 73 Accidental Structural Fires is close with an estimate of 9.37 tons/day. All four large categories are predominantly area sources that are difficult to control. (No. 73 is by definition impossible to control.)

There is always some potential for emission reductions via more stringent controls on known stationary sources. For example the basic grain loading limit could be reduced from the present 0.15 gr/SDCF level. Or the 40 lb/hr maximum emission rate could be reduced, or the maximum allowable opacity could be reduced from the present 20% (Ringelmann 1). These measures will be considered in Section V, but the inventory demonstrates that the greatest contributors to the particulate problem are the area sources with fugitive dust type emissions.

## Chemical Characterization of TSP Data

Suspended particulate matter in the air comes from many sources and thus has a complex and varying composition. Some comes from natural sources -- the sea, the land, volcanos, geysers -- but probably a greater portion is a result of man's activities, especially handling of materials, combustion, agriculture, and manufacturing.

Table 55. Companies with Particulate Emissions >100 tons/year

Source: BAAPCD Source Inventory, 1975

| Company | Location | tons/day | tons/year |
|---|---|---|---|
| C & H Sugar | Crockett | .8 | 292 |
| Chevron Chemical | Richmond | .3 | 110 |
| Collier Carbon | Rodeo | .6 | 219 |
| Exxon | Benecia | .8 | 292 |
| Fibreboard | Antioch | 1.3 | 475 |
| Kaiser Cement | Permanente | .5 | 183 |
| Owens Corning | Santa Clara | .7 | 256 |
| Owens Illinois | Oakland | .4 | 146 |
| Pacific Gas & Electric | Antioch | 1.0 | 365 |
| P.G. & E. | Hunters Pt.(S.F.) | .4 | 146 |
| P.G. & E. | Pittsburg | 2.3 | 840 |
| P.G. & E. | Potrero (S.F.) | .4 | 146 |
| Lion Oil* | Martinez | 1.7 | 621 |
| Shell Oil | Martinez | .5 | 183 |
| Standard Oil of Cal. | Richmond | 2.1 | 767 |
| Union Oil of Cal. | Rodeo | .8 | 292 |
| Total | | 14.6 | 5329 |

*was listed as Phillips Petroleum in 1975.

Table 56. Details of 1978 and 1985 Stationary Source Inventory (Particulate)

| No.** Category | | Annual Average Tons/day 1975 | 1985 | Major Point % | Area* % |
|---|---|---|---|---|---|
| PETROLEUM REFINING | | | | | |
| 1 | Refining Processes | 1.41 | 2.66 | 100 | 0 |
| 2 | Other Processes | .80 | 1.47 | 100 | 0 |
| 3 | Upsets, Breakdowns, Flares | .30 | .25 | 100 | 0 |
| CHEMICAL | | | | | |
| 6 | Sulfur | .28 | .22 | 100 | 0 |
| 7 | Sulfuric Acid | .06 | .09 | 100 | 0 |
| 9 | Other Chemical | 4.53 | 5.16 | 13 | 87 |
| OTHER INDUSTRIAL/COMMERCIAL | | | | | |
| 10 | Pulp and Paper | .82 | .95 | 100 | 0 |
| 11 | Metallurgical | 2.92 | 3.38 | 3 | 97 |
| 12 | Asphaltic Concrete | .79 | .73 | 100 | 0 |
| 13 | Concrete Batching | 1.11 | 1.27 | 0 | 100 |
| 14 | Glass Mfg. | 1.63 | 1.86 | 100 | 0 |
| 15 | Stone, Sand, Gravel | 15.16 | 17.30 | 0 | 100 |
| 16 | Sandblasting | 5.93 | 6.88 | 0 | 100 |
| 17 | Other Mineral | 3.74 | 4.26 | | |
| 18 | Farming | 10.53 | 10.30 | 0 | 100 |
| 19 | Food/Agric. Processing | 5.88 | 6.70 | 14 | 86 |
| 20 | Paint Spray Mist | 5.74 | 6.64 | 0 | 100 |
| 21 | Wood Products Mfg. | 4.69 | 5.34 | 0 | 100 |
| 22 | Other Industrial/Comm. | 16.35 | 18.60 | 2 | 98 |
| COMBUSTION OF FUELS | | | | | |
| 42 | Domestic | 4.38 | 4.97 | 0 | 100 |
| 43 | Comm./Institutional-Gas | 1.27 | 1.73 | 0 | 100 |
| 44 | -Oil | -- | -- | | |
| 45 | Oil Ref.Ext.Comb.-Natural Gas | 1.42 | 1.71 | 100 | 0 |
| 46 | -Ref.Make Gas | 1.36 | 1.90 | 100 | 0 |
| 47 | -Fuel Oil | .89 | 4.29 | 100 | 0 |
| 48 | -Coke | -- | -- | | |
| 49 | Power Plants-Gas Boilers | 1.86 | -- | 100 | 0 |
| 50 | -Oil | 2.77 | 14.50 | 100 | 0 |
| 51 | -Coal | -- | 1.08 | 100 | 0 |
| 52 | -Gas Turbines | -- | -- | | |
| 53 | -Oil | -- | 1.44 | 100 | 0 |
| 54-66 | Other Combustion | 2.40 | 4.45 | varies by category | |
| BURNING OF MATERIALS | | | | | |
| 67 | Residential Incineration | 1.06 | 1.21 | 0 | 100 |
| 68 | Comm./Inst. Incin. | .58 | .66 | 0 | 100 |
| 69 | Industrial Incin. | .08 | .09 | 0 | 100 |
| 70 | Agric. Debris Burning | 1.14 | 1.14 | 0 | 100 |
| 71 | Range/Forest Burning | .37 | .37 | 0 | 100 |
| 72 | Accidential Wild Fires | .28 | .27 | 0 | 100 |
| 73 | Accidential Structural Fires | 9.37 | 10.7 | 0 | 100 |

*"Area" sources include small [<0.1 ton/day] point sources.
**Category (numbers) not appearing in table have no particulate emissions.

AQMP Tech Memo 24 (see Reference 12) included a study of the chemical composition of the TSP catch at three Bay Area problem stations -- Livermore, San Jose and Fremont -- based on 1975 annual averages. Only partial chemical analysis was available, as the data were not originally intended as a complete analytical scheme. But the limited results are informative, and a composition summary table for Livermore is shown here as Table 57. These results were obtained by a series of mass balances using known or estimated composition of various sources and the partially known composition of the TSP catch.

The proposed source origin scheme could account for about 85 % of the measured particulate catch at Livermore. Soil particles made up about 35% of the catch, soot and organics about 24%, and sea salt up to 10%, tire dust 7%, secondary nitrates and sulfates 7% and auto exhaust 2%. The auto exhaust value appeared low and the tire dust high compared to limited data from Southern California (see Reference 19). The sources mentioned above sum to 85% of the filter catch; the analyses provided no clues to the remaining 15%.

The soil-like contribution of 35% again implicates fugitive dust as the main component in the Livermore TSP catch. The organic component (24%) is probably about half primary soot emitted from combustion processes. This assumption is based on preliminary data from LBL Atmospheric Aerosol research projects. A substantial part may be secondary photochemical reaction products, formed in the atmosphere from gaseous precursors (hydrocarbons and oxides of nitrogen). This would be most important on summer oxidant days, but less important on winter days when most TSP excesses are observed.

Though the analysis provides some explanation of the particulate problem, it does not give us detailed clues to efficient control measures. Three key weaknesses can be mentioned.

a) Since the TSP problem is so variable over space and time, one needs detailed source and filter catch compositions for a single day (an excess day) to pinpoint the sources contributing to the excess. The annual average data cited above provide only general guidance.

b) The biggest category, soil-like particles, could be a result of wind suspension, or could have been stirred up by man's activities (vehicles, construction, quarrying, etc.).

c) The soot and organics category may be amenable to some control, but it is not yet clear if combustion products or organic gases, or both, are responsible. Control measures would be very different for the two cases.

A comprehensive program to collect particle size and composition data has been proposed (see Reference 12) -- but not yet implemented -- to identify

Table 57. Various Source Contributions to Livermore Particulate Catch
Concentrations in $\mu g/m^3$ of ambient air

1975 Annual Average

| | Soot & Organic | Soil | Sea Salt | Second. Nitrate | Second. Sulfate | Auto Exhaust | Tire Dust | TOTAL | DATA |
|---|---|---|---|---|---|---|---|---|---|
| Organic | 16.33* | 1.37 | | | | .61 | 4.19 | 22.5 | 22.5 ± .6 |
| $SiO_2$ | | 11.15 | | | | | | 11.15 | 11.15 ±.1 |
| Cl | | | 3.64 | | | .16 | | 3.8 | 3.8 ±2.1 |
| $NO_3$ | | | .07 | 3.29 | | | | 3.36 | 3.36 ±.1 |
| $SO_4$ | | | .46 | | 1.18 | | | 1.64 | 1.64 ±.1 |
| Pb | | .005 | | | | .61 | | .61 | .61 ±.1 |
| Zn | | .002 | | | | .003 | .072 | .077 | .077±.01 |
| Subtotal | 16.33 | 12.53 | 4.17 | 3.29 | 1.18 | 1.38 | 4.26 | 43.14 | 43.14±3.1 |
| Other | - | 10.75 | 2.45 | ? | ? | .14 | .54 | 13.88 | 21.1 |
| TOTAL | 16.33 | 23.28 | 6.62 | 3.29 | 1.18 | 1.52 | 4.80 | 57.0 | 67.0 ± 6 |
| error | ±.4 | ±2.4 | ±3.9 | ±.1 | ±.25 | ±.32 | ±1.15 | ±8.5 | |
| Percent** Contrib. | 24.4 | 34.7 | 9.9 | 4.9 | 1.8 | 2.3 | 7.2 | 85.2 | 100 |
| error (%) | ±.6 | ±3.6 | ±5.8 | ±.1 | ±.4 | ±.5 | ±1.7 | ±12.7 | |

* by difference, so that total of organics row will be equal to DATA value.

** percentage which each source column contributes to measured (corrected) DATA TOTAL.

the sources which cause TSP excesses in the Bay Area. The project would be somewhat expensive, but the cost is moderate compared to the control measures now contemplated; especially if the lack of data results in poor choices. For the present, however, reliance must be on the data now available, with some professional judgment and cost considerations, for alternative control measures.

Emission Projections

Table 56 shows that baseline stationary source emissions are not expected to change very much from 1975 to 1985. Slight increases are expected in most categories because of expanding population and economic activity. A notable increase, about 10 tons/day, is foreseen from combustion of fuels at power plants, with a transition from gas to oil and possibly coal. AQMP baseline projections, including stationary and mobile sources, are shown in Table 58 for 1975, 1985 and 2000.

EPA guidelines (see Reference 17) suggest a new emission factor for dust from paved roadways, that is fugitive dust resuspended in the air as a result of vehicle passage. The factor of .012 lb per vehicle mile, if applied to Bay Area total VMT, produces emission rates that overwhelm the entire existing particulate inventory. The results are shown in Table 59. The traditional inventory (of all stationary and mobile sources) for 1975 showed 169 tons/day, supposedly including vehicle exhaust and tire dust. The fugitive dust from paved roads would provide an addition of 411 tons/day for a new total of 580 tons/day. Roadway dust, said to be 90 wt. % below 30 μ (see Reference 17), should thus make up some 70% of the average ambient TSP in 1975 -- even more in future years. The Bay Area monitors are all in urban areas and often traffic influenced, yet total soil-like particles have been found to be below 35% of the TSP filter catch. This 35% includes soil-like particles from all sources, including industry, construction, agriculture and nonurban background. It is larger than the soil dust fractions reported in other urban areas (see Reference 20).

Clearly, the roadway dust emission rate should depend on season, vehicle speed, vehicle size, and state of the roadway. The composite factor now proposed seems much too high. If other fugitive dust estimates, from unpaved roads, agriculture, construction, demolition, storage, etc. were added to the inventory, the soil-like component would be predicted well above 70%. The TSP composition data available do not support this hypothesis.

The emission rate could be very large if most of the mass were lost by fallout before the material reaches the monitor. The fugitive dust document, however, suggests that most emissions are small particles that would remain suspended for a long time. These estimates are shown in Table 60. Particle sizes are very small for most categories, and by weight most of the material is $<10$ μ. The half-lives for settling out of 15 μ particles are fairly long, greater than one hour except for stable con-

Table 58. Particulate Emissions by Major Source Category

(Reference: AQMP/Tech Memo 11)

| Source Category | Baseline Emissions (Tons/Day) 1975 | 1985 | 2000 |
|---|---|---|---|
| Petroleum Refining | 2.5 | 4.4 | 5.8 |
| Chemical | 4.9 | 5.2 | 6.1 |
| Other Industrial/Commercial | 75.3 | 80.8 | 90.5 |
| Combustion of Fuels | 16.3 | 34.5 | 30.7 |
| Burning of Materials | 12.9 | 13.9 | 22.5 |
| Off-Highway Mobile Sources | 5.2 | 6.3 | 7.8 |
| Aircraft | 9.0 | 11.4 | 19.4 |
| Light-duty Automobiles | 27.8 | 18.8 | 22.3 |
| Other Motor Vehicles | 15.2 | 16.3 | 19.8 |
| Total | 169 | 192 | 225 |

Table 59. Fugitive Dust from Paved Roads

Emission Factor: .012 lb/mi, EPA-450/2-77-029, pp. 3-8)

| Year | Regional VMT* (miles/day) | Vehicle Dust (tons/day) | Traditional Inventory Total Particulate (tons/day) |
|---|---|---|---|
| 1965 | 47,295,853 | 284 | 190 |
| 1975 | 68,608,127 | 411 | 169 |
| 1985 | 85,910,789 | 515 | 192 |
| 2000 | 116,927,835 | 702 | 225 |

*VMT data from AQMP/Tech Memo 12, Appendix A, Table 1.

Table 60. Particle Size Estimates for Various Sources

Reference: EPA-450/2-77-029, Appendix D

| Source Type | Weight % of particles less than stated size | | |
|---|---|---|---|
| | 30 μ | 10 μ | 5 μ |
| Point Sources | 99 | 98 | |
| Area Sources | 99 | 98 | |
| Motor Vehicles | 93 | 91 | |
| Aircraft | 93 | 91 | |
| Aggregate Storage | 100 | 100 | 100 |
| Construction | 100 | 66 | |
| Paved Roads | 90 | | 50 |
| Agriculture | 80 | 62 | |
| Feed Lots | 60 | 40 | |
| Off-road Vehicles | 60 | 40 | |

ditions. With the given 2.4 m/sec wind, the half-life "range" would be 4 kilometers, even under very stable conditions. Thus rapid physical removal does not seem to offer a good explanation for the discrepancy between the large calculated fugitive dust inventory and the smaller observed soil-like particulate catches.

The data sources for the EPA factor of .012 lb/mile do have overlapping ranges, but the two averages differ by an order of magnitude. The overall average is very near the larger value, and it appears, is much too high. This example emphasizes the tremendous uncertainties associated with fugitive dust calculations. Certainly all source inventory calculations are subject to sizeable error brackets, but many categories have benefitted from intensive study and repeated testing through the years. Fugitive dust calculations, by contrast, are still in a rather primitive state. Fugitive and natural emissions should, without a doubt, be included in source inventories for all pollutants. The process may require several iterations, however, to achieve the degree of credibility now accorded to stationary source inventories.

Other possibilities exist, to explain the observed discrepancy between inventory particulate catch. The traditional source inventory could be much too low, by a factor of about 5. Or the particle size distribution of local soils could be very different from the test soils. However, it is unlikely that the BAAQMD source inventory could be so far off, especially on an annual average basis. It is prepared with careful methodology and documentation. As to the soil particle size, a local soils expert (see Reference 21) found that Bay Area soil samples have substantial silt (2-50 μ) and clay (0-2 μ) fractions, similar to the EPA road dust. Considering the difficulties of testing, the fugitive dust emission factor still seems to be most subject to error. (A recent communication from Region IX EPA (see Reference 22) suggests that the factor of .012 lb/mile for paved road dust should be used only for non-freeway roads, and should be construed to include exhaust and tire dust particulates.)

## EXISTING CONTROL PROGRAMS

Particulate matter, as visible smoke and dust, has probably been the most noticeable form of air pollution throughout history, and was the subject of earliest control efforts. The control of particulate emissions has become a diversified effort, with several agencies holding regulatory power over Bay Area sources.

### Stationary Sources

The Bay Area Air Pollution Control District -- now the Bay Area Air Quality Management District -- was established in 1955 to develop effective programs for the reduction of air contaminants within the district. Previously, only local ordinances were used to control air pollution. The BAAQMD's enabling legislation includes the first specific source

controls, the regulation of open burning. It also prohibits the discharge of air contaminants which cause a public nuisance (public nuisance is demonstrated by a certain number of complaints). As of October 1978, the district has enacted 10 regulations and four of these affect particulate matter from stationary sources. These are summarized in Table 61. Regulations 7 and 8 are based directly on EPA rules for new source performance standards and hazardous pollutants. The district new source review rules (§1308 and §1309 of Regulation 2) were adopted by the California Air Resources Board (ARB) for the BAAQMD.

Only regulations directly related to particulate matter are considered here. There are also numerous limitations on gaseous pollutants ($SO_2$, organics and $NO_x$), which may be precursors in the formation of secondary aerosol.

Motor Vehicles

The Air Resources Board is also responsible for setting emission limitations on motor vehicles sold or registered in the State of California. The State has generally been very aggressive in this endeavor, with state standards set earlier and more stringent than federal standards for hydrocarbons, carbon monoxide and, in some cases, $NO_x$. So far, however, there has been no direct regulation of particulate emissions from vehicles. But the hydrocarbon and CO standards brought catalytic converters, together with unleaded gasoline, with resulting lower particulate emission rates from vehicle exhausts.

Since emission factors are 0.34 gm/mi for leaded fuel light vehicles, and 0.05 gm/mi for unleaded fuel (see Reference 23), this inadvertent control should significantly reduce exhaust emissions by 1985 when more than 96% (see Reference 18) of light duty vehicles will be catalyst models. Again, however, the reduction of 0.29 gm/mi may well be overshadowed by increased fugitive dust emissions of 5 gm/mi (see Reference 17), as Bay Area VMT is projected to increase from 68 million miles/day in 1975 to 86 million miles/day in 1985 (see Reference 18).

Aircraft

EPA promulgated in 1976 a set of emission standards for various types of aircraft engines. These standards were to be applicable to new engines beginning in 1979, and represented pollutant reductions up to 98% of the existing emission rates for HC, CO and $NO_x$. None of the new standards apply, however, to particulate emissions.

Other Sources

A state law (Title 17, California Administrative Code, subchapter 6) controls sandblasting techniques, abrasives, and visible emissions. There is a general opacity limit of 20%, but the opacity may be 40% under certain conditions, mainly with use of ARB certified abrasives.

Table 61. Summary of Particulate Regulations for Stationary Sources

| Reg.No. | BAAPCD Section | General Description |
|---|---|---|
| 1 | 2000 | Bans open burning; regulates agricultural burning. |
| 2 | 3110 | Limits smoke/dust opacity to 20% (Ringelmann 1). |
| 2 | 3131 | Limits Sulfuric acid mist concentration to .04 GR/SDCF. |
| 2 | 4112.2 | Limits concentration to .05 GR/SDCF (at 6% $O_2$) for large incinerators. |
| 2 | 4111.2) 5111.2) 6111.2) | Prohibit emission of large (individually visible) particles. |
| 2 | 5112 ) 6112.1) | Limit stack concentration of PM to 0.15 GR/SDCF at 6% $O_2$. |
| 2 | 6112.2 | Limit mass emission rate to 40 lb/hr. |
| 2 | 6112.3 | Lower limit on grain loading to be required for control (from 0.1 GR/SCF for small sources to 0.02 GR/SCF for large). |
| 2 | 12110 | Prohibits lead emissions which would produce >1 $\mu g/m^3$ ground level concentration by modeling (24 hr average). |
| 2 | 12111.1 | Prohibit lead emission which would cause ground level concentration >1 $\mu g/m^3$ over background by monitoring (30 day average). |
| 2 | 1308 | Require BACT* on new or modified sources emitting >15 lb/hr. |
| 2 | 1309 | Require tradeoffs for new or modified sources emitting >25 lb/hr. |

Table 61. (cont.) Summary of Particulate Regulations for Stationary Sources

| BAAPCD Reg.No. | Section | General Description |
|---|---|---|
| 7 | | New source performance standards |
| | 2 | Limits emission rate for steam generators to 0.1 lb/$10^6$ BTU. |
| | 3 | Limits incinerator emissions to .08 GR/SDCF at 12% $O_2$. |
| | 4 | Limits cement plant emissions to 0.3 lb/ton feed to kiln and limits opacity to 10%, except kiln may be 20%. |
| | 5 | Limits opacity of nitric acid plant to 10%. |
| | 6 | Limits sulfuric acid plant mist to 0.15 lb/ton product, and opacity to 10%. |
| | 7 | Limits asphalt concrete plant to .04 GR/SDCF. |
| | 8 | Limits refinery catalytic cracking systems to 1 lb/1000 lbs coke. |
| | 10 | Limits secondary lead smelter furnaces to .022 GR/SDCF, and burn off pot furnaces to 10% opacity. |
| | 11 | Limits secondary brass and bronze smelter furnaces to .022 GR/SDCF, and blast (cupola) or electric furnaces to 10% opacity. |
| | 12 | Limits iron and steel plants to .022 GR/SDCF. |
| | 13 | Limits sewage treatment sludge incinerators to 1.3 lb/ton of dry sludge input. |
| | 14 | Limits phosphate fertilizer fluoride emissions. |
| | 15 | Limits steel plant electric arc furnaces to .0052 GR/SDCF from control devices, also opacity. |

Table 61. (cont.) Summary of Particulate Regulations for Stationary Sources

| Reg.No. | BAAPCD Section | General Description |
|---|---|---|
| 7 | 16 | Limits flouride emissions and opacity from primary aluminum reduction plant operations. |
| | 17 | Limits primary copper smelter ore dryers to .022 GR/SDCF. |
| | 18 | Limits primary zinc smelter sintering machines to .022 GR/SDCF. |
| | 19 | Limits primary lead smelter furnaces and sintering machines to .022 GR/SDCF. |
| | 20 | Limits coal preparation plant dryers to .031 GR/SDCF; and pneumatic cleaning equipment to .018 GR/SDCF and 10% opacity. |
| | 21 | Limits ferroalloy arc furnaces to 0.99 lb/MW-hr or 0.51 lb/MW-hr (depending on alloy) and 15% opacity. Limits dust-handling equipment to 10% opacity. Prohibits "visible gases" from arc furnaces. |
| 8 | | <u>Emission standards for hazardous pollutants</u> |
| | 2 | Controls visible emission from asbestos manufacture, spraying. |
| | 3 | Limits beryllium emission to 10 gm/day or .01 $\mu g/m^3$ 30 day average. |
| | 4 | Limits beryllium emissions from rocket motor firing to 10 gm/day. |
| | 5 | Limits mercury emission to 3.2 kg/day. |

A more general law, employed on some occasions for particulate control is the "public nuisance" section in the State of California Health and Safety Code (Division 20, Chapter 2.5, Article 10, §24360). This prohibits "...discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of persons...." This provides very broad coverage of many pollution situations, but is sometimes difficult to enforce. It has been used successfully for dust abatement at construction and demolition sites.

Future Prospects

Traditional baseline emission inventory trends, Table 58. do not show great promise for improved air quality for TSP. The inventory increases slowly, about 1.5% per year, through 1985 and 2000. A rollback (roll-forward?) interpretation would predict a proportional deterioration in air quality, such that each station mean would increase over the years, with possibly more excesses of the standards.

[illegible]

# Section-V

# ALTERNATIVE TSP CONTROL MEASURES

The Livermore exceedances of the primary AGM in 1975 and 1976 have been attributed to three unusual factors: local construction, drought conditions, and extreme restrictive meteorology. A map of the Livermore site is provided in Figure 63, along with a record of construction activities in the immediate area of the station. The 1977 and 1978 monitoring records indicate that the primary standard will not be exceeded in normal years.

For attainment of the secondary national standard, a variety of control measures can be considered to reduce TSP inventories and ambient readings, although these are not currently being recommended in the plan. For stationary sources, there could be more stringent opacity and grain loading limitations. For vehicles, retrofit particulate traps could be required. And for fugitive dust control, road maintenance and soil stabilization could be improved. Also, more effective dust control could be required during construction and demolition projects.

## STATIONARY SOURCES

The BAAQMD Engineering Division made a calculation of the particulate emission reductions to be achieved by the most stringent controls (short of shutting down the sources). This was a scenario requiring BACT on all new and existing sources. A list of BACT criteria is shown in Table 62. This control program should achieve a reduction of 45 tons/day by 1985 and 53 tons/day by 2000. The origins of these reductions are shown in Table 63 by source category.

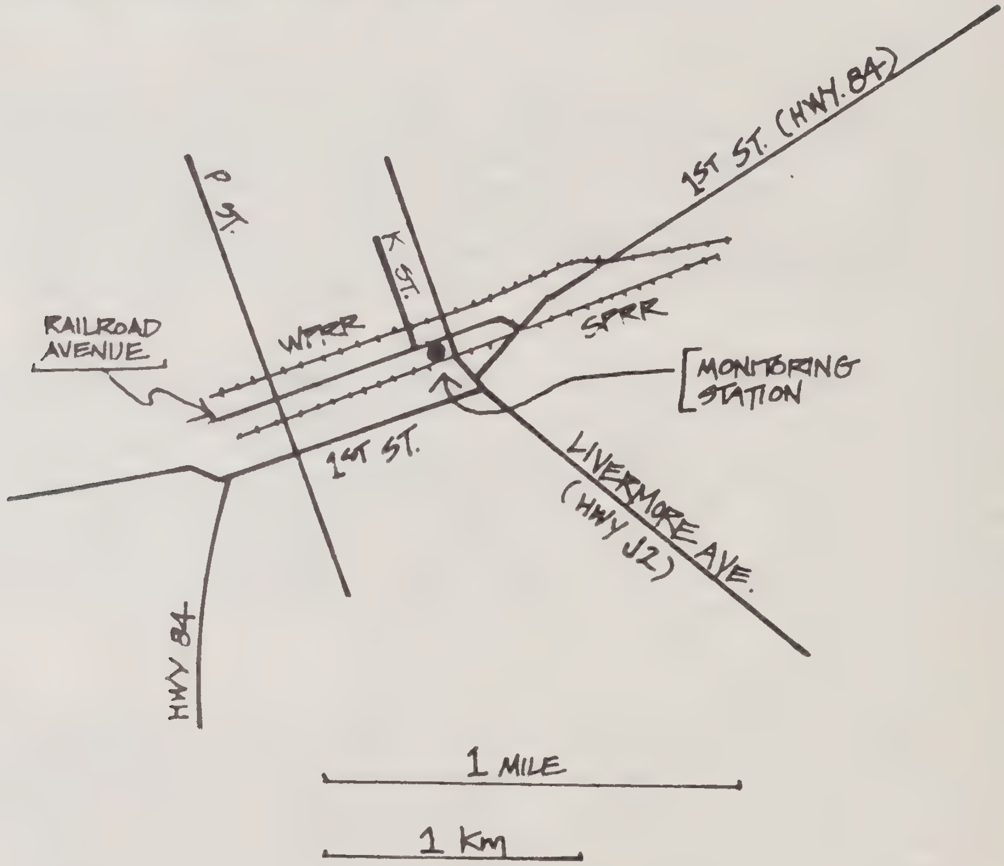
## MOBILE SOURCES

Aside from roadbed emissions, which will be considered as fugitive dust, there are only two obvious control measures for motor vehicle particulate emissions. Exhaust emissions could be controlled by fuel specification or by particulate traps in the exhaust system.

For fuel choice, unleaded gasoline should provide lowest particulate emissions, about .05 gm/mi (see Reference 23) with or without a catalytic converter. Leaded gasoline is expected to produce .34 gm/mi (see Reference 23) and diesel fuel engines about .7 gm/mi (see Reference 23), all data quoted for light vehicles. Diesel particulate emissions may be much more pernicious from the standpoint of visibility and catalytic potential. The soot from diesel exhaust appears to behave like activated carbon in providing adsorption sites and catalytic function for formation of secondary particulates in the atmosphere. Thus increased use of diesel-powered vehicles could increase sulfate and nitrate levels in ambient air. Sulfates are considered to be hazardous even at very low concentrations; the California standard (24-hr average) is 25 $\mu g/m^3$ or .0064 ppm. Thus the use of unleaded gasoline would be favored to reduce particulate emission from

FIGURE 63

# LIVERMORE MONITORING SITE




CONSTRUCTION PROJECTS IN THE VICINITY OF THE STATION

| NO | DATES | DESCRIPTION |
|---|---|---|
| 1 | 7/75 - 12/76 | RAILROAD RELOCATION - MOVE SP TRACKS FROM SP RIGHT-OF-WAY TO WP ROADBED. |
| 2. | 6/74 - 3/76 | LIVERMORE AVENUE UNDERPASS. HIGHWAY GOING UNDER RAILROAD. |
| 3. | 6/74 - 2/76 | P STREET UNDERPASS, ROAD UNDER RR |
| 4. | 74 - 75 | RELOCATION OF HIGHWAY 84, EARTH MOVING ALONG SP RIGHT OF WAY. |
| 5. | 11/74 - 9/75 | SHOPPING CENTER CONSTRUCTION AT RAILROAD AVENUE AND P STREET |
| 6 | 8/74<br>8/75<br>8/76 | RESURFACE RAILROAD AVENUE<br>"<br>" |
| 7. | 9/75 - 12/75 | BUILDING CONSTRUCTION, RR AVE & K STREET |

TABLE 62. Best Available Control Technology for Particulate Matter from Certain Sources

| No. | Process | BACT Description | Performance Criteria |
|---|---|---|---|
| 1. | Fluid catalytic cracker & coker | 3-stage electrostatic precipitator | 10 to 15 lb/hr |
| 2. | Boilers and furnaces | A. low sulfur fuel oil | 0.25% sulfur |
| 3. | Feed mills | A. baghouses<br>B. electrostatic precipitator | 99% at 1 μ<br>86% at 1 μ |
| 4. | Fish meal rendering | A. scrubber with incinerator<br>B. chlorine injection and chemical scrubber | 98-99%<br>95-99% |
| 5. | Concrete Batch | baghouse | 99% at 1 μ |
| 6. | Rock plants | water spray system with wet agent | 99% |
| 7. | Hot asphalt, Perlite | A. baghouse<br>B. venturi scrubber with baghouse | 99% at 1 μ |
| 8. | Abrasive | A. baghouse<br>B. venturi scrubber<br>C. shrouding | 99% at 1 μ<br>97% at 1 μ |
| 9. | Abrasive blasting, unconfined | A. water injection<br>B. hydroblasting<br>C. certified (dry) abrasives | 70-80%<br>100% |
| 10. | Rock drills | water injection | 70-80% |

TABLE 62. Best Available Control Technology for Particulate Matter from Certain Sources (Continued)

| No. | Process | BACT Description | Performance Criteria |
| --- | --- | --- | --- |
| 11. | Burn out ovens brake shoe debonders | starved air combustion plus afterburner | 90% |
| 12. | Incineration of waste | A. starved air combustion plus afterburner | 90% |
| | | B. baghouse | 99% at 1 μ |
| 13. | Concrete, flour and grain storage silos | baghouse | 99% at 1 μ |
| 14. | Metal, melting wire recovery | A. baghouse<br>B. venturi scrubber | 99% at 1 μ |
| 15. | Tire buffers | water injection | 70-80% |
| 16. | Architectural coatings | low solvent coatings | 70-80% |

TABLE 63. BACT Reductions (Particulate) for 1985 and 2000

| No.** | Category | Baseline Inventory Tons/Day 1975 | 1985 | 2000 | Reductions Tons/day 1985 | 2000 |
|---|---|---|---|---|---|---|
| | PETROLEUM REFINING | | | | | |
| 1 | Refining Processes | 1.41 | 2.66 | 3.50 | 1.40 | 1.00 |
| 2 | Other Processes | .80 | 1.47 | 1.93 | .40 | .60 |
| 3 | Upsets, Breakdowns, Flares | .30 | .25 | .33 | .15 | .13 |
| | CHEMICAL | | | | | |
| 6 | Sulfur | .28 | .22 | .30 | .12 | .20 |
| 7 | Sulfuric Acid | .06 | .09 | .12 | -- | -- |
| 9 | Other Chemical | 4.53 | 5.16 | 6.10 | 2.60 | 3.10 |
| | OTHER INDUSTRIAL/COMMERCIAL | | | | | |
| 10 | Pulp and Paper | .82 | .95 | 1.12 | .45 | .60 |
| 11 | Metallurgical | 2.92 | 3.38 | 3.99 | 1.70 | 2.00 |
| 12 | Asphaltic Concrete | .79 | .73 | .86 | .60 | .10 |
| 13 | Concrete Batching | 1.11 | 1.27 | 1.50 | 1.20 | 1.30 |
| 14 | Glass Mfg. | 1.63 | 1.86 | 2.19 | 1.00 | 1.10 |
| 15 | Stone, Sand, Gravel | 15.16 | 17.30 | 20.40 | 11.30 | 12.40 |
| 16 | Sandblasting | 5.93 | 6.88 | 8.15 | 3.10 | 4.00 |
| 17 | Other Mineral | 3.74 | 4.26 | 5.03 | 2.10 | 4.00 |
| 18 | Farming | 10.53 | 10.30 | 10.20 | -- | -- |
| 19 | Food/Agric. Processing | 5.88 | 6.70 | 7.92 | 3.40 | 3.90 |
| 20 | Paint Spray Mist | 5.74 | 6.64 | 7.85 | 4.00 | 4.80 |
| 21 | Wood Products Mfg. | 4.69 | 5.34 | 6.31 | 2.60 | 3.20 |
| 22 | Other Industrial/Comm | 16.35 | 18.60 | 22.00 | 9.30 | 11.00 |
| | COMBUSTION OF FUELS | | | | | |
| 42 | Domestic | 4.38 | 4.97 | 5.90 | | |
| 43 | Comm./Institutional-Gas | 1.27 | 1.73 | 3.18 | | |
| 44 | -Oil | -- | -- | -- | | |
| 45 | Oil Ref.Ext.Comb.-Natural Gas | 1.42 | 1.71 | 2.11 | | |
| 46 | -Ref.Make Gas | 1.36 | 1.90 | 2.51 | | |
| 47 | -Fuel Oil | .89 | 4.29 | 6.59 | | |
| 48 | -Coke | -- | -- | -- | | |
| 49 | Power Plants-Gas Boilers | 1.86 | -- | -- | | |
| 50 | -Oil | 2.77 | 14.50 | 3.09 | | |
| 51 | -Coal | -- | 1.08 | .77 | | |
| 52 | -Gas Turbines | -- | -- | -- | | |
| 53 | -Oil | -- | 1.44 | 1.44 | | |
| 54-66 | Other Combustion | 2.40 | 4.45 | 7.00 | | |
| | BURNING OF MATERIALS | | | | | |
| 67 | Residential Incineration | 1.06 | 1.21 | 1.43 | | |
| 68 | Comm./Inst. Incin. | .58 | .66 | .78 | | |
| 69 | Industiral Incin. | .08 | .09 | .11 | | |
| 70 | Agric. Debris Burning | 1.14 | 1.14 | 1.14 | | |
| 71 | Range/Forest Burning | .37 | .37 | .37 | | |
| 72 | Accidental Wild Fires | .28 | .27 | 27 | | |
| 73 | Accidental Structural Fires | 9.37 | 10.70 | 12.50 | | |
| | TOTALS - STATIONARY SOURCES | 111.90 | 144.57 | 158.99 | 45.40 | 53.50 |

vehicles and other small gasoline engines, such as lawn mowers, generators, chain saws, etc.

Table 64 shows the maximum incremental particulate reduction achievable by use of unleaded gasoline in some non-catalyst vehicles for 1985 and 2000. Note that the baseline inventory already assumes that 96% of light vehicles will be catalyst equipped, and thus already using unleaded gasoline by 1985. Thus, substantial reductions in exhaust emissions have already been considered (see Table 58 "Light Duty Automobiles"). Also shown in Table 64 are the maximum possible reductions achievable with retrofit particulate traps, with a performance standard of 57% reduction (see Reference 24) from conventional muffler emissions. The columns marked "Both" represent maximum reduction attainable, with both measures implemented.

If particulate traps can be used with existing diesel engines, substantial reductions in particulate emissions can be attained, from trucks buses, tractors, construction equipment, ships and locomotives. Total particulate emissions from these sources was 7.64 tons/day in 1975, mostly from trucks and construction equipment. A reduction of 4.35 tons/day would be achieved with particulate traps of 57% efficiency.

AEROSOL PRECURSORS

Since sulfates make up about 5% of the Livermore particulate catch (see Table 57) and nitrates about 2%, these constituents do not show great potential for reductions. The soot and organic component of about 24 weight per cent is somewhat more promising, however. With the soot component expected to be about half of the 24%, the other 12% is probably secondary organic aerosol, which will decrease with the hydrocarbon/oxidant control measures suggested in the plan. A total reduction of 43% in hydrocarbons is required by 1985 in order to meet the Federal oxidant standard of .08 ppm by 1985. This represents a total reduction of about 350 tons/day from all sources (see Reference 4), and assuming organic aerosol formation is proportional to ozone production, a 55% reduction in both pollutants is expected. Livermore ambient AGM would decrease by about 7% or 5 $\mu g/m^3$.

Although the percentage contributions of sulfates and nitrates to the total particulate load are small in the Livermore sample, a more representative sample from other areas would have to be analyzed to ascertain the existence of a secondary particulate problem in the Bay Area.

For $SO_2$ and $NO_x$, application of BACT on certain stationary sources would produce the reductions shown in Table 65. $SO_2$ reductions on the order of [illegible] of the total inventory could be achieved through use of BACT on new and existing stationary sources. $NO_x$ reductions would be only about 10%. If secondary sulfate and nitrate are reduced in proportion to precursor emissions, Livermore ambient AGM would decrease by about 3% or 2 $\mu g/m^3$.

Table 64. Particulate Reduction from Use of Unleaded Gasoline and Retrofit Particulate Traps

| Source Category No. | Description | Unleaded Gas. 1985 | Unleaded Gas. 2000 | Part. Traps 1985 | Part. Traps 2000 | Both* 1985 | Both* 2000 |
|---|---|---|---|---|---|---|---|
| | | Reduction (ton/day) | | | | | |
| 74 | Ag tractors | .12 | .12 | .08 | .08 | .13 | .13 |
| 76 | Constr. Equip. | .23 | .31 | .15 | .21 | .25 | .35 |
| 87 | Lawn mowers | .14 | .15 | -- | -- | -- | -- |
| 88 | Misc. engines | .27 | .32 | -- | -- | -- | -- |
| 94 | Cars & lt. trucks | .53 | .72 | 3.28 | 4.46 | 3.50 | 4.77 |
| 98 | Hvy. gasol. trucks | 1.35 | 1.84 | 1.81 | 2.46 | 2.39 | 3.25 |
| 106 | Motorcycles-2 str. | -- | -- | .15 | .20 | .15 | .20 |
| 107 | Motorcycles-4 str. | .03 | .04 | .03 | .05 | .05 | .06 |

*Note that emission reductions are not additive.

Assumptions

Particulate traps can reduce particulate emissions by 57%, whether unleaded or leaded gasoline.

Cat. 74 All gasoline tractors could use unleaded gasoline with 85% reduction in particulate emissions from leaded gas value (N.B. tractor use outside urban areas has little impact or urban TSP).

76 85% reduction achievable, as with light duty vehicles.

87 85% reduction with unleaded. Lawn mowers not suitable for retrofit particulate traps.

88 85% reduction with unleaded. Not suitable for part. traps

89-93 (Aircraft) Only small and/or old planes use gasoline. Those require high octane aviation gas. Unleaded could not be used.

Assumptions (Continued)

Cat. 94 Assume 96% of light vehicles will require unleaded by 1985; resulting emissions reductions already figured in baseline inventories for 1985 and 2000. Figures in unleaded column represent incremental reduction if half of remaining 4% switch to unleaded.

98 Half of trucks could switch to unleaded. 42% category reduction. (The switch to unleaded is not based on retrofit of trucks; however, a particulate trap would represent a retrofit measure).

106 Two-stroke emissions reduced 57% by particulate trap, unaffected by unleaded fuel.

107 Assume half of four-stroke motorcycles could use lower octane unleaded gas. 42% category reduction.

TABLE 65. $SO_2$ and $NO_x$ Inventories, Baseline and BACT Stationary Source Reductions for 1985 & 2000

A. Sulfur Dioxide $SO_2$ (tons/day)

| Category | Baseline Values* 1975 | 1985 | 2000 | BACT Reductions** 1985 | 2000 |
|---|---|---|---|---|---|
| Petroleum Refining | 39.0 | 67.5 | 88.9 | 32.0 | 42.5 |
| Chemical | 84.6 | 89.1 | 119.8 | 84.9 | 112.3 |
| Other Indus./Commercial | 5.9 | 6.5 | 7.4 | .1 | .1 |
| Combustion of Fuels | 43.7 | 213.9 | 129.9 | 93.5 | 56.5 |
| All other sources | 45.8 | 58.0 | 68.0 | -- | -- |
| Total - All Sources | 219.0 | 435.0 | 414.0 | 211.0 | 211.0 |
| % Reduction | -- | -- | -- | 48 | 51 |

B. Oxides of Nitrogen as $NO_2$ (tons/day)

| Category | Baseline Values* 1975 | 1985 | 2000 | BACT Reductions** 1985 | 2000 |
|---|---|---|---|---|---|
| Petroleum Refining | 5.9 | 15.2 | 20.0 | 2.8 | 3.7 |
| Chemical | 3.1 | 2.9 | 3.9 | 1.3 | 1.6 |
| Other Indus./Commercial | 2.5 | 2.7 | 3.1 | .4 | .4 |
| Combustion of Fuels | 196.0 | 321.1 | 279.8 | 72.4 | 67.9 |
| All other sources | 523.5 | 350.0 | 414.0 | -- | -- |
| Total - All Sources | 731.0 | 692.0 | 721.0 | 76.9 | 73.6 |
| % Reduction | -- | -- | -- | 11 | 10 |

*Reference AQMP/Tech Memo 11, pages 4-6.
**Calculated by BAAPCD Engineering Division, August 1977.

Mobile sources collectively also produce large amounts of organics and $NO_x$, with some $SO_2$. Vehicle emissions are controlled by State and Federal regulations, and expected reductions in vehicle emissions may decrease secondary aerosols also. Motor vehicle hydrocarbons will decrease by 55% (259 tons/day) from 1975 to 1985. This reduction has already been considered in the 350 tons/day mentioned above. Oxides of nitrogen from motor vehicles will be reduced by 36% (144 tons/day) by 1985. The resulting ambient TSP reduction would be less than 1 $\mu g/m^3$. Both pollutants will increase again with increased VMT for 2000, but will still be below 1975 levels (see Reference 18). The year 2000 calculations suppose enactment of mobile source controls to achieve emissions about 50% below 1977 prescribed levels.

$SO_2$ emissions from mobile sources will not be reduced unless the sulfur content of gasoline is regulated. This does not seem to be an efficient way to reduce either $SO_2$ or particulate emissions.

Based on the recent monitoring record, it is expected that the Livermore station AGM will be below 75 $\mu g/m^3$ for the forseeable future. The three conditions which contributed to high TSP in 1975 and 1976 (construction, drought and extreme restrictive meteorology) are not expected to recur, especially simultaneously. The general composition of the Livermore TSP is known, with 35% soil-like particles as the largest fraction and 24% soot/organics as the second largest. Since neither of these is amenable to modeling at this time, we rely on the developing monitoring record to demonstrate attainment by 1978. The 1977 AGM was 68 by BAAQMD calculation and the 1978 AGM is 63 through July 1978.

The soil particle fraction is not amenable to modeling because the source strengths are not known to the accuracy required here. The soot organic fraction cannot presently be modeled because soot source strengths are not known and no reaction chemistry is available to calculate secondary organic aerosol, whether on a prototype day or annual average basis.

Substantial reductions in the hydrocarbon inventory are expected as the oxidant plan is implemented, and the construction near the Livermore station (Figure 2) has been completed. Thus both fugitive dust and organic components should be substantially reduced, though the reductions may not be quantified except through the monitoring record. After two clean years, 1977 and 1978 Alameda County may be redesignated by the ARB or EPA as an attainment area with respect to the national primary particulate standards.

The attainment of secondary standards in four counties presents a more difficult problem, where the solution will depend on control of fugitive dust. With winter rural inland background values of about 30 $\mu g/m^3$ with excursions to 100 $\mu g/m^3$ (see Reference 25), it is clear that the estimation and control of fugitive dust will be a demanding and critical task. Preliminary calculations with EPA's emission factor for reintrainment on paved roads show that this would be a critical area for control. Koch (Reference 26), by contrast, found paved roads a <u>negligible</u> source of fugitive dust in the Baltimore area, and proposed emission factors 1/10 or 1/100 of the EPA value. It is clear that a useful calculation of fugitive emissions must depend on careful analysis of the existing data, and

possibly the publication of new research. Even with agreement on emission factors, the fugitive emissions calculations will require collection and analysis of new kinds of data in the Bay Area: crop acreage, unpaved roads and areas, soil moisture, soil particle sizing, precip./evaporation indices, etc. This exercise may require several person-years of work and up to one calendar year to accomplish.

The recommended approach to future TSP planning is discussed in Section X.

# Section-W

# REFERENCES FOR TSP CONTROL ANALYSIS

The numbered references in Sections T through V are for the following publications:


1. Association of Bay Area Governments, "Air Quality Maintenance Plan", Chapter VI in "San Francisco Bay Area Environmental Management Plan", Berkeley, CA, June 1978.

2. Federal Register, Vol. 41, No. 134, Monday, July 12, 1976, page 28603.

3. Federal Register, Vol. 43, No. 43, Friday, March 3, 1978 pages 8962-8964 and 8970.

4. Letter dated October 6, 1978, from W. H. Lewis, Exec. Officer, ARB to Paul DeFalco, Regional Administrator, EPA Region IX.

5. 40 CFR §50.7, page 5 of 1976 edition.

6. Bay Area Air Pollution Control District, "Information Bulletin, 5-11-77, Bay Area Total Suspended Particulates: 1969-1976" BAAPCD Technical Services Division, San Francisco, 1977.

7. S. K. Friedlander, "Small Particles in Air Pose a Big Control Problem," Environmental Science and Technology, Vol, 7, No. 13, Dec., 1978.

8. D. A. Levaggi, J.S. Sandberg, M. Feldstein "Total Anthropogenic Suspended Particulate as Derived from Chemical Analysis of Chloride and Silicate on High-Volume Samples" JAPCA, Vol. 26, No. 6, June 1976.

9. D. Grosjean, "Aerosols" in Ozone and Other Photochemical Oxidants, National Academy of Sciences, Wash. D.C., 1977, Chapt. 3.

10. T. Novakov, et al., "Atmospheric Aerosol Research, Annual Report 1976-77" LBL-6819, Lawrence Berkeley Laboratory, University of California, Berkeley, 1977.

11. T. A. Cahill, et al., "Analysis of Respirable Fractions in Atmospheric Particulates via Sequential Filtration," JAPCA, Vol. 27, No. 7, July 1977.

12. T. Perardi "Analysis of Suspended Particulate Matter in the San Francisco Bay Region," AQMP/Tech Memo 24, November 1977, Association of Bay Area Governments, Berkeley.

13. Federal Register, Vol. 43, No. 152, Monday August 7, 1978, pp. 34892-34934.

14. Bay Area Air Pollution Control District, Technical Services Division, "Contaminant and Weather Summary," November 1976 and December 1976, San Francisco.

15. Engineering Science, "Air Quality Monitoring Program During Winter 1976, Montezuma Hills, California." Arcadia, California, May 1976, (draft report).

16. Bay Area Air Pollution Control District, "BAAPCD Emissions Inventory SUMMARY REPORT, Base Year 1975," San Francisco, 1976.

17. U.S. Environmental Protection Agency, "Guideline for Development of Control Strategies in Areas with Fugitive Dust Problems," EPA-450/2-77-029 (OAQPS No. 1.2-071), Research Triangle Park, North Carolina, October 1977.

18. R. Wada and I. Kan, "Baseline Motor Vehicle Emission Inventory: Methodology and Results," AQMP/Tech Memo 12, Association of Bay Area Governments, Berkeley, August 1977.

19. S. K. Friedlander, "Chemical Element Balances and Identification of Air Pollution Sources." Env. Sci. & Tech., Vol. 7 No. 3, March 1973.

20. D. F. Gatz, "Relative Contributions of Different Sources of Urban Aerosols," Atmos. Env., Vol. 9, page 14, 1975.

21. I. Barshad, "A Pedologic Study of California Prairie Soils," Soil Science, Vol. 61, No. 6, page 429, June 1946.

22. Draft letter from R.M. Stenburg to A. Sherwood, citing C. Masser -- Personal communication with C. Owen, EPA Region IX, 18 October 1978.

23. U.S. Environmental Protection Agency, "Compilation of Air Pollutant Emission Factors," AP-42, Second Edition, Part B, Appendix D, 1976.

24. Calculated from data in W. G. Kunz, Jr. and E. N. Cantwell, Jr., "Design and Performance of Muffler Lead Traps for Vehicles," E. I. duPont de Nemours & Co., Wilmington Delaware, 1977.

25. Engineering Science, Inc., Draft Report "Air Quality Monitoring Program During Winter 1976, Montezuma Hills, California," Arcadia, California, May 1976.

26. R. C. Koch et. al. "Identifying Sources and Quantities of Fugitive Particulate Emissions in Baltimore," presented at the EPA Third Symposium on Fugitive Emissions: Measurement and Control, October 23, 1978, San Francisco.

# Section-X

# FUTURE WORK AND RESEARCH NEEDS FOR THE CONTINUING AIR QUALITY PLANNING PROCESS

In developing the initial air quality plan a number of future tasks and research needs have been identified. The continuing planning process established in the region will provide the appropriate forum for doing this work. The work may be categorized as follows:

- Data collection needed to support additional control programs
- Air quality analysis to support additional control programs
- Control strategy development and assessment for carbon monoxide, oxides of nitrogen, total suspended particulates, sulfur dioxide, and other pollutants as necessary
- Monitoring implementation of the initial plan to ensure that reasonable further progress is being made toward attainment of the oxidant and carbon monoxide standards.
- Development of a regional plan for review and adoption in the 1981-82 time period.

Requirements for additional data collection, air quality analysis, and control strategy development are summarized in Table 66 by pollutant.

Activities that are designed to follow up on the control programs adopted in this plan are necessary to ensure that the Bay Area continues to comply with the legal requirement for making "reasonable further progress" toward attainment of air quality standards. Immediate attention will be focused on developing detailed design specifications for each control program so that legally enforceable commitment for implementation can be secured, and the programs can be implemented as scheduled in the plan.

## IMPLEMENTING AND REFINING THE PHOTOCHEMICAL OXIDANT PLAN

A number of tasks must be pursued to ensure that the elements of the 1979 plan are being implemented. In addition to the specific actions identified in the plan for each governmental agency, the eventual programs implemented and their performance records must be monitored and related to what was called for in the plan. Certain programs may in practice turn out to be either more or less effective than what was estimated in the plan. If that should occur, the plan would need to be modified to account for the difference. In particular, the stringency of the New Source Review program will be evaluated.

TABLE 66. SUMMARY OF MAJOR TASKS FOR FUTURE AIR QUALITY PLANNING

| POLLUTANT | ADDITIONAL DATA COLLECTION | ADDITIONAL AIR QUALITY ANALYSIS | CONTROL STRATEGY DEVELOPMENT | MONITORING IMPLEMENTATION AND COMPLIANCE |
|---|---|---|---|---|
| PHOTOCHEMICAL OXIDANT | • Meteorological and emissions data for long range transport analysis<br>• Develop natural hydrocarbon emission inventory. | Long range transport analysis and testing of spatially variable controls. | As needed | • Monitor and evaluate implementation of adopted control programs. |
| CARBON MONOXIDE | • CO monitoring data in localized hot spots<br>• Meteorological data for a max. CO day<br>• Motor vehicle emission factor revisions | Detailed modeling of several localized CO "hot spots." | As needed | • Monitor and evaluate implementation of adopted control programs. |
| NITROGEN DIOXIDE | • Meteorological data for a max. $NO_2$ day | LIRAQ modeling analysis to test effectiveness of existing control programs for $NO_2$ levels. | As needed | As needed |
| TOTAL SUSPENDED PARTICULATES | • Implement more sophisticated monitoring equipment and chemical analysis techniques.<br>• Develop fugitive dust emission inventory. | Further refinement of the chemical mass balance technique. | As needed to attain Federal secondary standards. | As needed |
| SULFUR DIOXIDE | • Meteorological data for worst case $SO_2$/Ox/particulate day. | Develop forecasting analysis techniques to address State standard. | As needed | As needed |
| OTHER STATE POLLUTANTS | • Establish continuous monitors for ethylene<br>• Develop emission inventories for lead and ethylene | • Develop a model for sulfates<br>• Evaluate the effectiveness of existing controls on lead | As needed | As needed |

In addition to tasks that follow up on the adopted plan, other technical tasks should be undertaken to address the impact of Bay Area pollution on other parts of the State. In particular, the feasibility of extending the LIRAQ modeling analysis to cover larger areas will be investigated along with other alternatives. If an appropriate analysis technique can be developed, the impacts of different levels of NOx emissions in the Bay Area on other air basins will be tested. Once the role of Bay Area NOx emissions on neighboring regions is identified, appropriate control measures can be developed if necessary.

REFINING THE CARBON MONOXIDE PLAN

Current monitoring locations for carbon monoxide are not considered to provide data on maximum CO levels experienced in the region, and therefore probably underestimate the magnitude of CO levels experienced in the region. The current plan provides for attainment of CO standards based on existing data. In recognition of the limitations of the data the plan also calls for additional CO monitoring studies in known "hot spots," and subsequent development of additional control programs if found necessary. A pilot monitoring study is currently under way, and will be expanded to include all known CO problem areas in the Bay Area (San Jose, Sunnyvale, San Francisco, Oakland, and Vallejo). If these studies should indicate a need for development of additional control programs to attain CO standards, such programs will be developed in conjunction with the affected local jurisdictions.

A critical ingredient to developing further controls for carbon monoxide is obtaining policy agreement between the Environmental Protection Agency and the California Air Resources Board on future motor vehicle CO emission factors appropriate for use in California. A divergence of technical opinion exists at this time which affects whether or not a problem will exist in the future and whether further controls need to be pursued in the Bay Area. The California Air Resources Board recognizes the problem and is working with EPA to resolve the matter.

TASKS LEADING TO A NITROGEN DIOXIDE PLAN

Available evidence suggests that current violations of the State one-hour $NO_2$ standard may be primarily due to motor vehicle emissions. If so, the California Air Resources Board's existing motor vehicle control program may be sufficient to meet and maintain the State standard through the year 2000. To verify this hypothesis, meteorological data conducive to the buildup of high $NO_2$ concentrations would have to be developed for input to a detailed modeling analysis (e.g., using LIRAQ). A model verification analysis would have to be performed, and appropriate changes expected in NOx emission levels would have to be tested. If the analysis suggests that additional controls would be required to meet the State $NO_2$ standard, then alternative control measures would be developed and assessed.

Additionally, the 1977 Clean Air Act calls for the setting of a new Federal $NO_2$ standard for an averaging time no greater than three hours, if deemed appropriate by the EPA Administrator. If and when such a standard is promulgated by Federal regulation, prospects for attainment

and maintenance of that standard in the Bay Area will be assessed, and appropriate control measures developed as necessary.

TASKS LEADING TO A PLAN FOR ATTAINING FEDERAL SECONDARY TOTAL SUSPENDED PARTICULATE MATTER STANDARD

In developing the TSP plan, a preliminary analysis was made of the nature of the particulate problem in the region. In particular, an attempt was made to identify sources responsible for the problems. The analysis met with limited success because of specific deficiencies in the available data base. For example, a large fraction of the particulate matter currently measured consists of some form of organic matter. The fraction that is natural, e.g., insect parts and pollen, versus the fraction that is man-made such as soot and photochemical aerosols is unknown at this time. In addition, the portion of particulates due to background windblown dust versus what may be due to specific industrial or other human activity cannot be distinguished.

Rather than develop a plan based on indiscriminate controls over particulate emissions which may or may not contribute to the problem, a program for obtaining the necessary data has been outlined. The program consists of the purchase, installation, and maintenance of advanced particulate monitoring equipment, including sophisticated chemical analysis of the particulate samples obtained, development of a fugitive dust inventory, and the design and pilot testing of alternative fugitive dust control methods. Once the appropriate data are collected, the specific source categories responsible for elevated particulate levels in the atmosphere may be more clearly identified. Control strategies appropriate to the sources implicated would be developed and assessed.

TASKS LEADING TO A SULFUR DIOXIDE PLAN

As stated previously, the Federal sulfur dioxide standard is not currently violated in the Bay Area, nor are future violations expected at this time. The $SO_2$ standard adopted by the California Air Resources Board (.05 ppm $SO_2$ for 24 hours) is more complex than the Federal standard in that it requires a simultaneous violation of either the State oxidant standard (.10 ppm for one hour) or the State particulate standard (100 $\mu$g/m3 for 24 hours) at the same monitoring location.

If applied in 1975, this standard would have been violated once in the Bay Area. It is not possible at this time to forecast whether future violations will occur in the region because there is no known analytical technique for making such a forecast. Ambient sulfur dioxide levels will increase substantially by 1985; however, if the comprehensive strategy is implemented, the 0.08 ppm oxidant standard will be met by 1985-87. In addition, the State 24-hour particulate standard is most often violated in areas where there are no significant sources of sulfur dioxide emissions (i.e., Livermore, San Jose, and Fremont).

The future task for the continuing planning process is to develop methods for forecasting simultaneous violations of State standards as prescribed. Once these methods are developed and tested, alternative control measures can be developed if necessary.

## OTHER STATE POLLUTANTS

As part of the planning effort, available data concerning a number of other pollutants was reviewed. The pollutants were lead, sulfates, hydrogen sulfide and ethylene, and the California Air Resources Board has adopted ambient air quality standards for each of them. To develop a plan to meet those standards, a substantial body of information must be compiled. This information includes:

- ambient monitoring data to decide whether standards are being exceeded
- emission inventory data to identify the sources and amounts of emissions
- alternative control techniques for reducing the emisions
- an appropriate emissions/air quality relationship to identify existing problems and to project future ones.
- an analysis of whether proposed controls will be effective in eliminating the current and projected future problems

To the extent that funding support is provided, the data collection tasks will be pursued. At present, it does not appear that work related to State standards would receive Federal funding support.

### Lead

The information needed to prepare a plan for the attainment of the State lead standard can be compiled. It is quite probable that the existing controls on lead content of gasoline for new catalyst equipped vehicles will result in eliminating future lead problems. An analysis of this problem (or lack of one) should be conducted.

### Sulfates

The State sulfate standard has been violated once over the past eight years in the Bay Area. Projected reductions in the availability of low sulfur fuels (e.g., natural gas) will result in increased sulfur dioxide emissions, and thus may result in increased sulfate levels. On the other hand, decreases in oxidant levels may also result in lowered sulfate levels. The task for the continuing planning process is to develop and implement a technique for projecting future sulfate levels to determine whether the State standard will be violated in the region. There is no reliable technique available at this time.

### Hydrogen Sulfide

Existing BAAQMD regulations address the State standard for hydrogen sulfide and are currently being enforced. No additional plans or control programs appear necessary at this time.

Ethylene

Analysis of this pollutant is limited by the lack of ambient monitoring data and emission inventory data. Without ambient monitoring data, it is not possible to determine whether a problem exists. Future efforts for ethylene, therefore, require that a continuous monitoring program be implemented for that pollutant.

SUMMARY OF PLANNING TASKS FOR 1979-82

The following outline is a more detailed and complete listing of tasks identified for completion over the next three years. Responsibilities for conducting these tasks are assigned in a memorandum of understanding (see Figure 64). Tentative schedules for task completion grouped according to pollutant are summarized in Figures 65-67. The schedules also assume availability of planning funds (e.g., Section 175 funds) by January 1979.

A. Review and Update Previous Base Year Planning Assumptions and Methodologies

1. Collect localized ambient carbon monoxide monitoring data, traffic and meteorological data in known hot spots

2. Perform more extensive characterization studies of total suspended particulates

3. Review the status of current control programs

4. Review and update assumptions and methodologies for preparation of the baseyear source emission inventory

5. Prepare inventory of natural hydrocarbon emissions

6. Prepare an inventory of fugitive dust emissions

7. Develop methods for analyzing air quality trends for measuring progress toward attainment of air quality standards

8. Develop methods for monitoring changes in regional vehicle miles traveled

9. Review air quality modeling techniques for all pollutants

10. Investigate the feasibility of and need for establishing an interagency Bay Area air quality modeling data center

B. Prepare an Updated Base Year Emission Inventory for the Bay Area

C. Prepare a Review of Base Year Air Quality Data Collected in the Region

D. Review and Update Projections of Emissions and Air Quality

1. Review and update the ABAG Series III projections of population, employment, and land use in the Bay Area

2. Review and update the MTC travel model projections

3. Prepare forecasts of energy supply and demand in the Bay Area

4. Prepare updated schedules for implementation of previously adopted controls, including legal, financial, and manpower commitments

5. Prepare updated emision inventory projections

6. Prepare updated baseline air quality projections for ozone

7. Prepare updated baseline air quality projections for carbon monoxide

8. Prepare updated baseline air quality projections for nitrogen dioxide

9. Prepare updated baseline air quality projections for sulfur dioxide

10. Prepare updated baseline air quality projections for total suspended particulates

11. Perform additional emissions sensitivity analyses to determine degree of additional control required to attain air quality standards for each pollutant

E. Prepare an Annual Report on the State of the Region's Air Quality and Progress Toward Attainment of Air Quality Standards

F. Prepare an Updated Analysis of Alternative Oxidant/Oxone Control Strategies

1. Compile an inventory of alternative controls

2. Perform preliminary screening analysis of the control alternatives

3. Prepare detailed designs and cost and effectiveness estimates for alternative stationary source controls (including Available Control Technology and New Source Review)

4. Prepare detailed designs and cost and effectiveness estimates for previously adopted transportation controls

5. Assess the impact of alternative control strategies on air quality within the region and neighboring regions

6. Develop draft plan recommendations for additional controls necessary to attain the oxidant/ozone standard

G. Prepare an Updated Analysis of Alternative Carbon Monoxide Control Strategies

1. Inventory CO control alternatives beyond those previously adopted for oxidant control, including potential stationary source CO control measures

2. Perform a preliminary screening analysis of the control alternatives

3. Prepare detailed designs and cost and effectiveness estimates for the most promising additional control alternatives

4. Assess the air quality impact of both the previously adopted transportation controls and the additional controls identified

5. Develop draft plan recommendations for additional controls needed to attain the carbon monoxide standards in known problem areas

H. Prepare an Updated Analysis of Alternative Control Strategies for Attainment of the Federal Secondary Standards for Total Suspended Particulate

1. Inventory TSP control alternatives

2. Perform a preliminary screening analysis of the control alternatives

3. Prepare detailed designs and cost and effectiveness estimates for the most promising control alternatives

4. Assess the air quality impact of the most promising control alternatives

5. Develop draft plan recommendations for controls needed to attain the Federal secondary standards for total suspended particulate matter

I. Prepare an Impact Assessment for All Draft Plan Recommendations

1. Assess the impact of plan recommendations on other areas of environmental concern

2. Assess the social and economic impacts of plan recommendations

   - Perform a least-cost analysis of the plan recommendations

   - Investigate the impact of New Source Review on industrial growth in the Bay Area

   - Develop an industrial siting process for the Bay Area

3. Assess the legal and institutional requirements for implementing the draft plan recommendations

J. Prepare the Draft 1982 Non-Attainment Area Plan for Review by Local Regional, State and Federal Agencies

1. Identify actions needed to attain Federal primary air quality standards in the Bay Area

2. Identify additional actions needed to attain Federal secondary standards and State standards

K. Conduct the Plan Review and Adoption Process

1. Review plan recommendations with policy bodies of ABAG, MTC, BAAQMD, and affected cities and counties

2. Conduct public hearings on the plan recommendations

3. Adopt 1982 Non-Attainment Area Plan for the Bay Area

4. Secure legally enforceable management agreements from designated implementing agencies.

FIGURE 64

MEMORANDUM OF UNDERSTANDING

BETWEEN

ASSOCIATION OF BAY AREA GOVERNMENTS,

BAY AREA AIR POLLUTION CONTROL DISTRICT

AND

METROPOLITAN TRANSPORTATION COMMISSION

I. PURPOSE

The purpose of this Memorandum of Understanding is to comply with Section 174(a) of the Clean Air Act as amended in 1977. Sec. 174(a) provides in part as follows:

> "Within six months after the enactment of the Clean Air Act Amendments of 1977, for each region in which the national primary ambient air quality standard for carbon monoxide or photochemical oxidants will not be attained by July 1, 1979, the State and elected officials of affected local governments shall jointly determine which elements of a revised implementation plan will be planned for and implemented or enforced by the State and which such elements will be planned for and implemented or enforced by local governments, regional agencies or the state."

The San Francisco Bay region is a non-attainment area. The Clean Air Act as amended requires these regions to develop a revised State Implementation Plan (SIP) and to develop procedures for implementation of the SIP. An organization must be designated as lead planning organization. There must be joint determination of which elements of the SIP will be planned for and implemented by each of the agencies involved. This Memorandum is being prepared to satisfy in part the above stated requirements.

II. REGIONAL AGENCIES

The parties to this Memorandum are the Association of Bay Area Governments (ABAG), the Bay Area Air Pollution Control District (BAAPCD) and the Metropolitan Transportation Commission (MTC), sometimes referred to herein as the "regional agencies".

III. LEAD AGENCY

The parties recommend that ABAG be certified by the State as the "organization of elected officials of local government" with primary responsibility for preparing the revised non-attainment plan pursuant to Section 174(a) of the Clean Air Act as amended. However, the parties agree that effective air quality planning will require the expertise and cooperation of MTC and BAAPCD as well as ABAG.

IV. STATUTORY RESPONSIBILITIES

The parties affirm and support the statutory responsibilities of each of the regional agencies which is a party to this Memorandum. A general description of these responsibilities follows:

ABAG

ABAG is a voluntary joint powers, comprehensive regional planning agency for the nine Bay Area counties. It is established under the Joint Exercise of Powers Act (Government Code Sections 6500-6513) by counties and cities within the San Francisco Bay Region. ABAG is the federally designated Areawide Planning Organization and Areawide Clearinghouse for this region. It is the agency designated by the State of California to develop an areawide wastewater treatment management plan under Section 208 of the Federal Water Pollution Control Act of 1972. ABAG is also designated under state legislation as the regional solid waste management planning agency.

MTC

MTC is established under Government Code Section 66500-66522 as the agency responsible for the development, administration and implementation of the Regional Transportation Plan for the Bay Area. MTC has been designated as the Metropolitan Planning Organization responsible for the conduct of the Transportation Planning Process required by the Federal Aid Highway Act 1962.

In addition, Section 66517.5 of the Government Code authorizes MTC to develop transit service standards, Section 30886 of the Streets & Highways Code gives MTC authority to set tolls on state toll bridges in the Bay Area, and under Section 99302 of the Public Utilities Code, MTC is the statutory agency responsible for allocating Transportation Development Act funds to the nine Bay Area counties.

BAAPCD

BAAPCD is a basin-wide district governed by a Board of Directors composed of elected officials of local governments within the nine Bay Area counties. Under the California Health & Safety Code (Division 26, Part 3, Chapter 4) BAAPCD has primary responsibility in the Bay Area for control of air pollution from non-vehicular sources. Subject to the powers and duties of the California Air Resources Board, BAAPCD adopts and enforces rules and regulations to achieve and maintain air quality standards. BAAPCD is empowered to establish a permit system, which must insure that proposed sources do not prevent or interfere with the attainment or maintenance of air quality standards.

V. RESPONSIBILITY FOR NON-ATTAINMENT PLAN ELEMENTS

The parties agree that each regional agency shall exercise responsibility for determining and implementing revisions to the Non-attainment Plan elements in accordance with each agency's statutory responsibility. Final decision on elements and control measures to be included in the plan shall be made by the agency which exercises statutory responsibility over the element or control measure in question. In accordance with the foregoing, the regional agencies' responsibility for implementation plan elements and control measures is allocated as follows:

ABAG - Any plan elements related to regional development policy.

BAAPCD - Any plan elements and control measures dealing primarily with non-vehicular sources of air pollution.

MTC - Any plan elements which seek to reduce vehicular sources of air pollution by (1) encouraging alternate modes of travel, (2) reducing the quantity of travel, (3) shifting the spatial and temporal distribution of vehicular emissions.

In addition, those plan elements and control measures concerning the technological control of emissions from motor vehicles are, under state law, the responsibility of the Air Resources Board. As appropriate, the regional agencies may recommend to the Air Resources Board that additional motor vehicle (technological) control measures be adopted for the Bay Area.

VI. ANNUAL WORK PROGRAM

In order to prepare the revised non-attainment plan, an annual work program shall be developed jointly by the staffs of the regional agencies and approved by the governing body of each agency. The work program shall provide for a coordinated effort of the agencies' staffs and shall assign work tasks in accordance with the plan development and implementation responsibilities previously set forth and with the following principal divisions of functions:

ABAG
- o Development of regional land use and population activity forecasts
- o Development of regional economic forecasts
- o Analysis and monitoring of the effects of land uses on air quality
- o Coordination of public participation program
- o Overall review and coordination of air quality planning effort - data analysis, modelling, control strategy development and assessment
- o Submission of non-attainment plan revisions

BAAPCD
- o Monitoring and data analysis of ambient air quality and related meteorology
- o Maintenance of a detailed, distributed emissions inventory for modelling purposes, assessment of emission trends and projection of future emissions for non-vehicular sources

- o Assessment of air quality trends and projection of future air quality, including photochemical modelling
- o Development, analysis, and monitoring of non-vehicular source control measures for air quality effectiveness and cost-benefit considerations
- o Preparation, adoption and enforcement of regulations for the attainment and maintenance of air quality standards, including a permit system for new, modified, and existing sources.
- o Air quality impact analysis and review of plans and projects relative to SIP consistency, and technical advice and assistance thereon to local and regional public agencies.

MTC

- o Development of regional transportation policies and plans
- o Development of regional travel demand forecasts
- o Development, analysis and monitoring of transportation control measures
- o Projection of emissions from transportation sources

The parties agree to work together in preparing regional air quality projections. To the extent possible, common data bases and uniform forecasts of population, employment, land use, transportation, emissions and air quality will be used.

VII. PLANNING FUNDS

Any planning funds made available through the provisions of Section 175 of the Clean Air Act as amended in 1977 or through other relevant federal and state appropriations, shall be assigned to each regional agency in accordance with its plan development and implementation responsibilities and with the annual work program.

VIII. INTER-AGENCY RECOMMENDATIONS

A regional agency may make recommendations to another regional agency relative to the latter's plan development and implementation responsibilities, regardless of the statutory responsibility of the recommending agency.

IX. JOINT MANAGEMENT COMMITTEE

A three member air quality committee shall be established, consisting of the Executive Directors of ABAG and MTC and the Air Pollution Control Officer of BAAPCD, or their designees. The committee shall: 1) review and approve the annual air quality work program; 2) provide guidance and oversight to the joint technical staff work, and 3) establish a mechanism to coordinate the policy actions taken by each agencies' policy bodies. The committee shall meet as needed to facilitate conducting their responsibilities as cited above.

X. TIME LIMIT

This Memorandum of Understanding shall become effective when approved by the governing bodies of ABAG, BAAPCD and MTC, and shall expire two years from its effective date, unless further extended by the three agencies.

ASSOCIATION OF BAY AREA GOVERNMENTS

Rod Diridon, President — Date 6/15/78

BAY AREA AIR POLLUTION CONTROL DISTRICT

Sam Chapman
Sam Chapman, Chairman — Date June 21, 1978

METROPOLITAN TRANSPORTATION COMMISSION

Louise P. Giersch
Louise P. Giersch, Chairman — Date 5/24/78

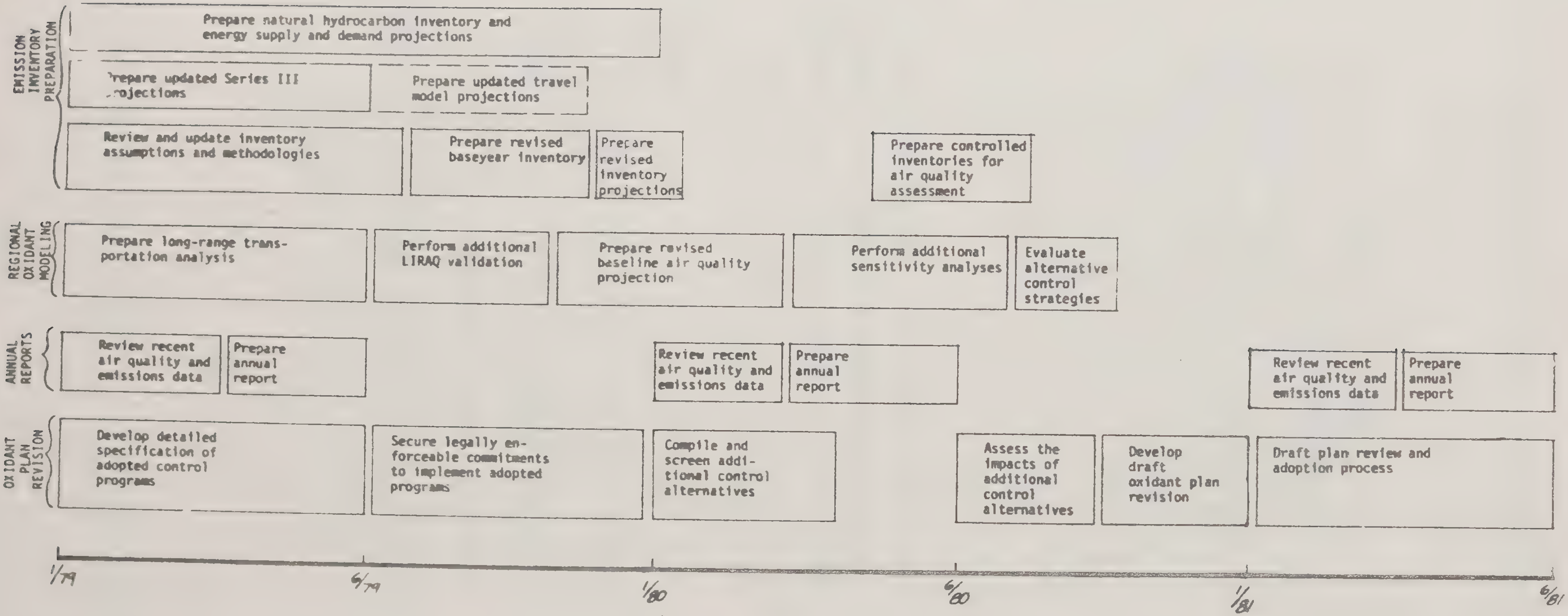



FIGURE - 65

TENTATIVE SCHEDULE FOR FUTURE WORK ON OXIDANT PLAN UPDATE

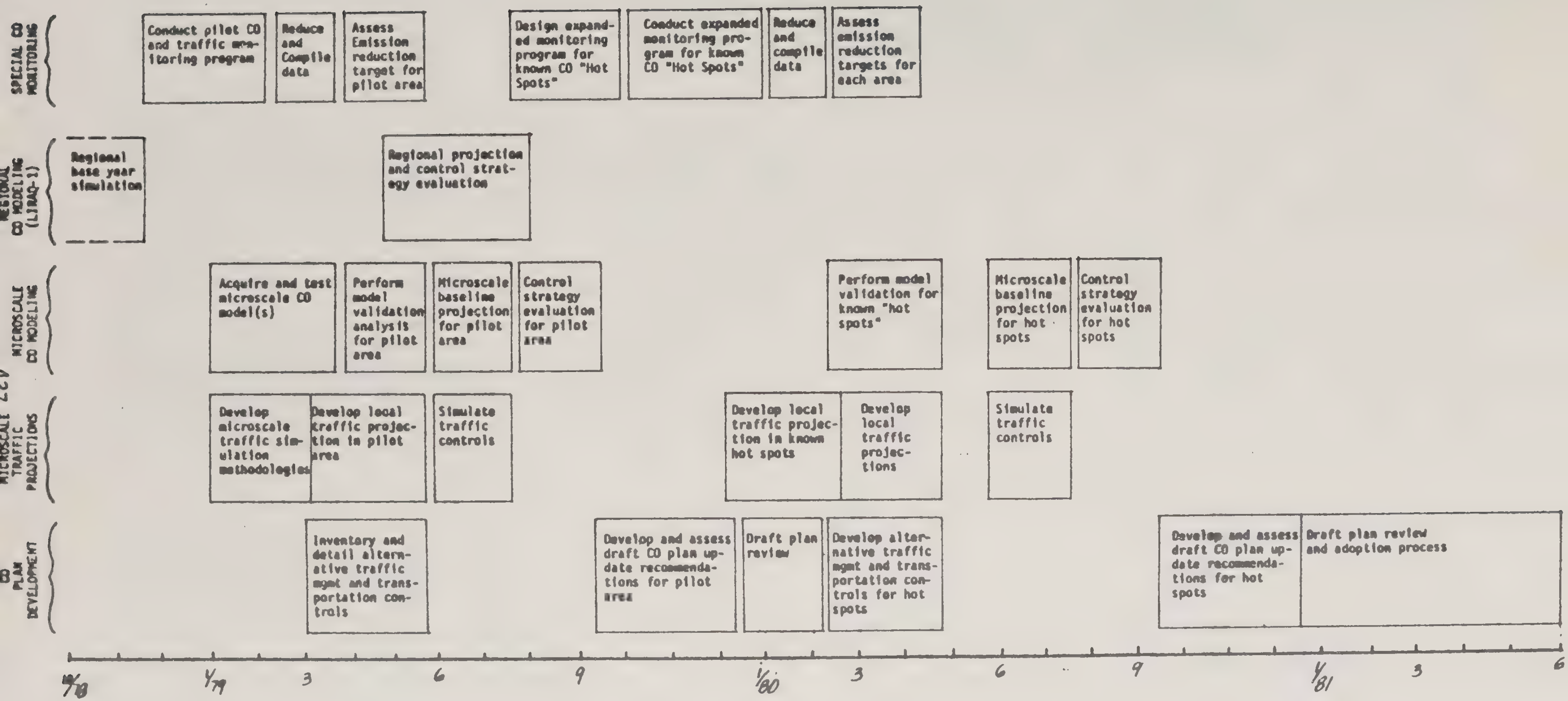



Figure - 66 TENTATIVE SCHEDULE FOR FUTURE WORK ON CARBON MONOXIDE PLAN UPDATE

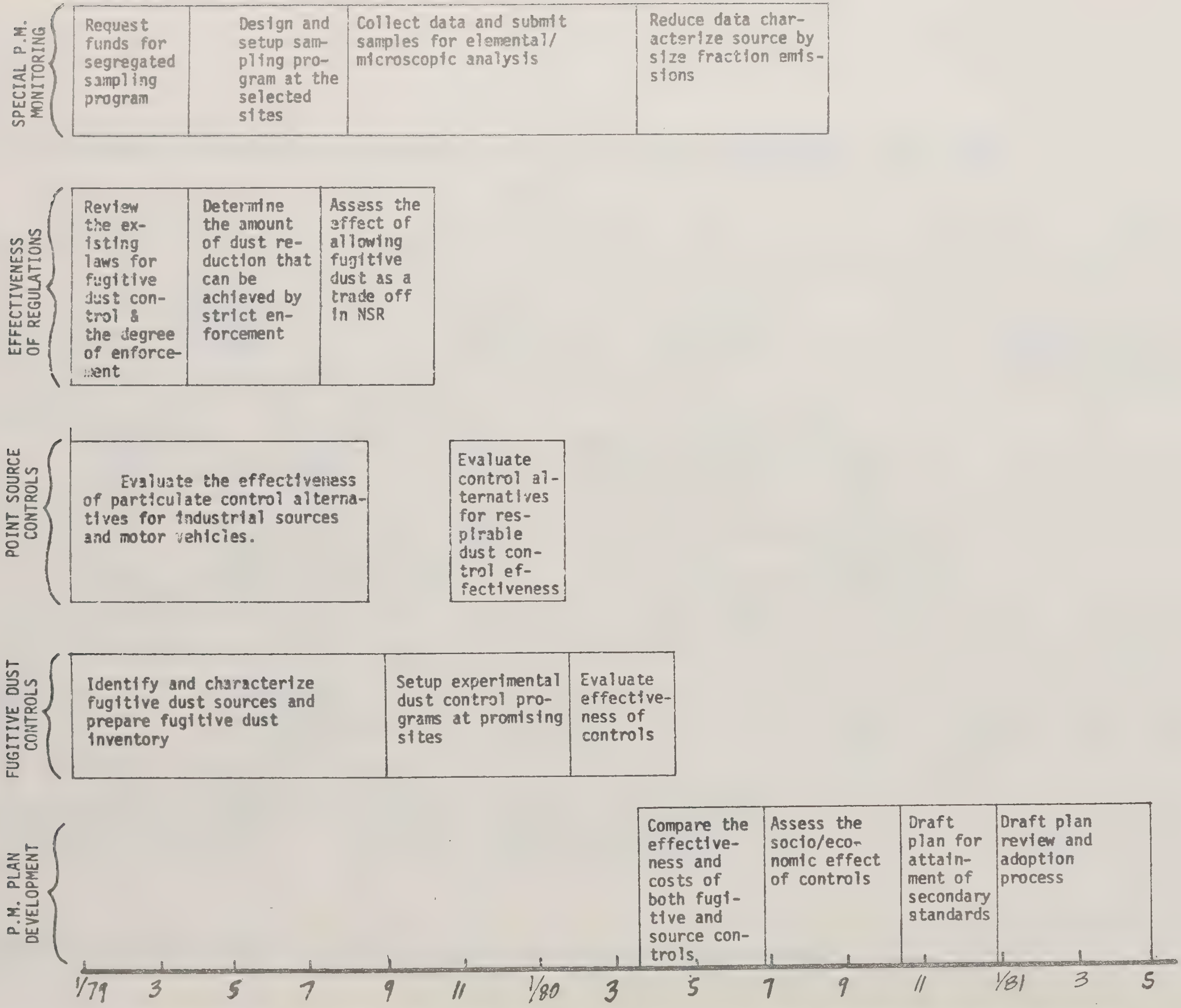



Figure 67 TENTATIVE SCHEDULE FOR WORK ON PARTICULATE MATTER PLAN UPDATE

## FUTURE PLANNING TASKS CORRESPONDING TO STATE AND FEDERAL COMMENTS ON THE 1979 PLAN

The oxidant portion of the 1979 Bay Area Air Quality Plan (previously known as the Air Quality Maintenance Plan) was submitted for public review in December 1977. As part of the Bay Area Environmental Management Plan, it was approved in modified form in June 1978 by the Association of Bay Area Governments General Assembly. The Plan was subsequently reviewed by the California Air Resources Board and the U.S. Environmental Protection Agency - Region IX Office. Their comments, received in October 1978, dealt primarily with two areas:

(1) the approvability of the Plan based on the provisions required by Section 172(b) of the Clean Air Act Amendments of 1977.

(2) the clarification and further documentation of certain technical questions.

During the review process, some major areas of discussion were raised in regard to whether <u>all</u> reasonably available control measures (for stationary and transportation sources) were included, the degree of financial and legal commitment to implementation that was demonstrated by the plan and the satisfactory demonstration of whether the adopted plan would result in further progress toward attainment of the federal oxidant standard.

In some cases, the "deficiencies" of the plan could be readily corrected by providing documentation in a form that would meet the CAAA requirements. In other cases, a satisfactory response required further analysis beyond what was already performed for the plan's development. Where further analysis could not be completed in a timely manner for incorporation into the current plan, the additional work required has been identified for study in the continuing planning process.

A summary of ARB and EPA comments that fell into the latter category is contained in Table 67, along with the corresponding work program task descriptions in response to the comments. The proposed tasks are designed to provide a full and complete response to all of the questions posed by the State and Federal agencies and to produce a plan that meets all of the Clean Air Act requirements. A grant application for planning funds under Section 175 of the 1977 Clean Air Act Amendments is being prepared to secure the funds needed to address the issues identified.

## ORGANIZATION FOR FUTURE PLAN PREPARATION AND ADOPTION

The institutional organization for both technical and policy evaluation of future updates to the Bay Area Air Quality Plan will rely heavily upon the mechanisms and procedures developed for the preparation of the 1979 plan. The Association of Bay Area Governments, designated under Section 174 of the 1977 Clean Air Act Amendments as the lead agency for preparation of the Non-Attainment Area Plan, will prepare and submit an application for Federal grant funds authorized under Section 175 of the Act to support the further work required. Consistent with the joint

memorandum of understanding between ABAG, the Bay Area Air Quality Management District, and the Metropolitan Transportation Commission, these latter agencies will continue to play key roles in all future planning and implementation activities related to the Bay Area Air Quality Plan. Key working groups and their responsibilities are as follows:

Technical Evaluation

- Joint Technical Staff - composed of staff members from ABAG, MTC, BAAQMD, ARB, EPA, and the California Department of Transportation (Caltrans). This group is responsible for development and technical assessment of effectiveness and impacts of alternative control strategies.

- Modeling Committee - composed of staff members with specialized air quality modeling expertise from ABAG, MTC, BAAQMD, Caltrans, ARB, EPA, and Lawrence Livermore Laboratory (LLL), Systems Applications, Inc. (SAI), and SRI International (formerly Stanford Research Institute). This group is responsible for specification of the air quality modeling methods to be used, and review of the results obtained.

- Air Quality Advisory Committee - composed of interested individuals from private industry, local government staff, and special interest groups. This committee is the vehicle by which progress on plan preparation is communicated to interested individuals and organizations that are not participating directly in the effort. It provides a formal and continuous opportunity for such individuals to communicate concerns and comments on the work being done both to staff and to the various policy bodies who will be reviewing the plan.

- Interagency Management Group - composed of executive staff of ABAG, MTC, and BAAQMD. This group functions to provide key administrative and policy guidance to the Joint Technical Staff and serves as a bridge between technical staff and the policy review bodies.

- ABAG Regional Planning Committee (RPC) - This committee is composed of elected representatives of cities and counties in the Bay Area, and representatives of special and public interest groups. It functions as the principal policy review body in ABAG for plan development, inheriting the role of ABAG's Environmental Management Task Force.

- ABAG Executive Board - This group is composed of elected representatives of cities and counties in the Bay Area, and functions as the month-to-month governing board for ABAG. All plans and matters of regional policy produced by ABAG must receive review and approval by the board.

- Metropolitan Transportation Commission - This group is composed primarily of elected representatives of cities and counties in the Bay Area, and functions as the governing board for MTC. All plans, funding priorities and policies related to transit and major transportation projects must receive review and approval by this board.

- BAAQMD Board of Directors - This group is composed of elected representatives of counties in the Bay Area, and functions as the governing board for the BAAQMD, with authority over stationary source emission controls. The activities and regulations of the District must receive review and approval by this board.

- ABAG General Assembly - This body includes elected representatives from each ABAG member city and county of the Bay Area. Each year, the General Assembly approves the annual update of the Environmental Management Plan.

- California Air Resources Board - This body is composed of individuals appointed by the Governor and has the authority to set motor vehicle emission standards. It also is responsible for preparation and submittal of the State Implementation Plan for California to EPA. In addition, it can override the authority of local air pollution control districts such as the Bay Area Air Quality Management District in regulating emissions from stationary sources.

The technical evaluation of plan alternatives and the preparation of future plan recommendations will be focused in the Joint Technical Staff. The composition of this group is structured such that those agencies with potential responsibility for implementation of individual plan components can participate directly in the development of the plan. Since some of the potential transportation controls expected to be considered would require implementation by individual cities and counties in the Bay Area, the existing Joint Technical Staff will be augmented by planning and public works department staff from affected jurisdictions.

Once the draft plan recommendations are prepared, they will undergo simultaneous review by RPC, MTC, the BAAQMD Board, and affected local city councils and county boards of supervisors. Position statements and recommended amendments to the draft plan will be developed by each of these policy bodies and submitted to the ABAG Executive Board and General Assembly for consideration and approval. Following General Assembly approval of the plan, a series of management agreements will be negotiated with each implementing agency identified in the plan. These agreements will be in the form of legally enforceable commitments to implement the specific plan elements, and will become part of the plan to be submitted to ARB and EPA for approval.

Table 67. A Summary of the California Air Resources Board and EPA Review Comments and the Task Designations to Respond

| Review Comment | Response/Task |
|---|---|
| • The current plan lacks regulations that reflect the application of reasonably available control technology to existing stationary sources (refers primarily to hydrocarbon emissions). | • During the Plan's development, guidelines on reasonably available control technologies (RACT) were published by EPA. However, these guidelines were received after the technical analysis for selecting the Plan's control strategies had already been performed. An analysis has been performed to resolve questions on: the effectiveness of RACT in the Bay Area, the adequacy of the strategies currently recommended in the Plan, and the need for additional controls. (See Table 29B.) Additional analysis will be performed in Tasks A-3, 4, B, C, D-5, 6, 11, F-1 through F-3 |
| • The non-attainment area plan does not address carbon monoxide and total suspended particulates. | • Carbon monoxide and total suspended particulate control programs were developed and submitted for review and adoption in October, 1978. The approved control measures have been included in the non-attainment area plan. A crucial aspect of both programs is the further characterization of the problems (which may be more severe than the existing data indicate) through updated data analysis techniques. These would be performed in Tasks A-1, 4, 7, 8, D-7, 11 and G-1 through G-5 for carbon monoxide; and Tasks A-2, 4, 6, 7, D-10, 11 and H-1 through H-5 for total suspended particulates. |

| Review Comment | Response/Task |
|---|---|
| • The non-attainment area plan lacks documentation of adoption and commitment by the responsible implementing agencies to the appropriate control measures. | • Existing documentation as of December, 1978 has been incorporated into the plan. Further documentation will be provided as it becomes available in Tasks D-4, E, F-4, 6, I-3, K-1, 2, 3, 4, J-1, 2. |
| • Some of the estimates in the baseline emissions inventories and estimates of control effectiveness are questionable or need to be updated. | • In the course of the Plan's development, additional work by the California Air Resources Board revealed new information on Bay Area industrial emissions. Additional data on emissions also becomes available with improved monitoring techniques. The Plan therefore requires periodic updating to be addressed in Tasks A-3, 4, 5, 8, B, C, D-1, 2, 4, 5, 6, 7, 8, 9, 10, 11, F-1, 3, 4. |
| • The air quality modeling analysis should be performed for a wider variety of meteorological conditions. | • Task D-6, 11. |
| • Further information on how the transportation control measures were selected is needed; in particular, further justification is required as to why those measures in Section 108 (f)(1)(A) of the CAA not in the Plan, were excluded. | • Section G has been included in response to this comment. Additional documentation will be developed as needed in Tasks F-1, 2, 3, 5, 6, G-1, 2, 3, 4, 5. |
| • The Plan's baseline inventories need to be updated to reflect the impacts of the potential energy policies of the nation and the State or regional air quality, e.g., the availability of clean fuels and alternative means for generating electricity. In particular, describe the potential effects on $NO_x$ and $SO_x$ emissions. | • Task A-4, B, C, D-3. |

| Review Comment | Response/Task |
| --- | --- |
| • The Plan should show the administrative and procedural requirements of the permitting authority that covers alternative siting review for new sources, i.e., an analysis of alternative sites, sizes, production processes and environmental control techniques. | • Task I-2d. |
| • The Plan does not show the impact of New Source Review or industrial growth in the Bay Area. | • The specific provisions of the New Source Review rule continue to evolve with time (e.g., ARB has recently developed a new model rule for consideration statewide). Whatever form the rule eventually assumes, its impact will be evaluated in Task I-2. |
| • The Plan should make an explicit demonstration of the ability of the adopted controls to maintain reasonable further progress. | • This explicit demonstration has been provided in the plan for oxidant and carbon monoxide as required. Additional work to monitor and review progress are addressed in Tasks D-4, 5, 6, 7, 8, 9, 10, 11, E, J-1, 2. |
| • The Plan needs to be expanded to address attainment of all state standards and outstanding problems related to attainment of secondary federal ambient air quality standards. | • If appropriate funding support can be obtained, the following tasks will address State standards in addition to federal secondary standards: Tasks D-7, 8, 9, 10, E, F, J-2. |